Project Manual

100% Construction Documents

NEW CARDIAC CATHETERIZATION LAB SUITE & HYPERBARIC FACILITY EXPANSION RIVERSIDE UNIVERSITY HEALTH SYSTEM

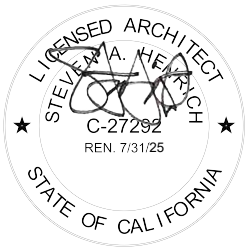
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(Package 1 of 4: Sections 02 41 20 thru 09 65 16)

Leo A. Daly
Project No. 047-10071-002
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SECTION 00 01 07 – SEALS PAGE

 Stamp & Signature of Architect of Record	 Stamp & Signature of Structural Engineer of Record
 Stamp & Signature of Mechanical Engineer of Record	 Stamp & Signature of Electrical Engineer of Record

REVIEWED IN ACCORDANCE WITH
THE REQUIREMENTS OF T24, CCR
APPROVED
Allen Cheng,Senior Architect
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DIVISION 02

EXISTING CONDITIONS

SECTION 02 41 20 – SELECTIVE BUILDING DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Systematic removal of portions of buildings and structures.
   2. Salvage of existing items for reuse.
   3. Salvage of construction materials for recycling.
   4. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

1.2 REFERENCES

A. Definitions:
   1. Remove: Means to detach from existing construction and legally dispose off-site.
   2. Demolish: Means the same as “remove”.
   3. Dispose: Means to get rid of by throwing away; or by giving or selling to someone else.
   4. Reuse: Means to use again for the same function without re-processing.
   5. New-Life Reuse: Means to use again for a different function without re-processing.
   6. Remove and Salvage: Means to detach from existing construction, prepare for reuse or storage as applicable, and then deliver to the Owner.
   7. Remove and Reinstall: Means to detach from existing construction, prepare for reuse, and reinstall where indicated.
   8. Recycle: Means to detach from existing construction, break down into raw materials, and then process the materials to make new items.
   9. Existing-to-Remain: Means existing items that are not removed, reused, or recycled.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Demolition drawings are diagrammatic and show existing conditions with information developed from field surveys and to generally show the extent and type of demolition required. The Owner will maintain conditions existing at the time of inspection for bidding purposes as far as practicable.
   1. Before beginning demolition, make a detailed survey of existing conditions indicated below in Part 3 of this specification Section, and report discrepancies or conflicts between Drawings and actual conditions in writing to the Architect for clarifications and instructions.

2. Do not proceed, when such conflicts or discrepancies occur, before receipt of the Architect's instructions.

B. Pre-Demolition Meeting:
1. To review methods and procedures related to the work of this specification Section, hold a meeting at the project site after submittal approval and at least 10 business days before beginning installation. At a minimum, the Contractor, demolition subcontractor, and Architect must attend the meeting.
2. During the meeting, review the Contract Documents, submittals, project conditions, and demolition sequence and methods, including special details and conditions that might affect demolition.
   a. Review and discuss existing conditions survey indicated below in Part 3 of this specification Section.
   b. Inspect and discuss condition of construction to be selectively demolished.
   c. Review structural load limitations of existing structure.
   d. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
   e. Review requirements of work that rely on substrates exposed by selective demolition operations.
   f. Review areas where construction is existing-to-remain and requires protection.
3. Identify and discuss adverse or unfavorable conditions detrimental to protecting or demolishing construction. Resolve each condition.
4. Finalize construction schedule.
5. Record significant discussions and distribute meeting minutes. Do not begin demolition until disagreements are successfully resolved to the satisfaction of all parties.

1.4 SUBMITTALS

A. Informational Submittals:
1. Schedule of Selective Demolition Activities: Indicate the following.
   a. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
   b. Interruption of utility services. Indicate how long utility services will be interrupted.
   c. Coordination for shutoff, capping, and continuation of utility services.
   d. Use of elevator and stairs.
   e. Locations of proposed dust- and noise-control temporary partitions and means of egress.
   f. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed work.
   g. Means of protecting existing-to-remain items in the path of waste removal.

2. Inventory: After selective demolition is complete, submit a list of items that have been removed and salvaged.
3. Pre-Demolition Photographs or Videos: Submit videos or photographs showing existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by selective demolition operations.

1.5 QUALITY ASSURANCE

A. Quality Standards: Comply with the safety requirements of both American National Standards Institute/ American Society of Safety Engineers publication ANSI/ASSE A10.6. "*Safety Requirements for Demolition Operations*" and National Fire Protection Association publication NFPA 241, "*Standard for Safeguarding Construction, Alteration, and Demolition Operations*".

1.6 PROJECT CONDITIONS

A. Hazardous Materials: Hazardous materials may be encountered in the building or at the project site. If materials suspected of containing hazardous materials are encountered, then do not disturb; promptly notify the Architect and Owner.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure adequate supervision practices are followed at the project site before demolition work begins and at all times during installation.

B. Survey: Engage a professional engineer to survey condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective demolition operations.
   1. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
   2. Provide means to have digital molds created to repair ornate items in case of loss (e.g., laser cloud point scan).
   3. Inventory and record the condition of items removed and reinstalled and removed and salvaged.
   4. When unforeseen mechanical, electrical, or structural elements are encountered that conflict with intended function or design, investigate and measure the nature and extent of conflict. Promptly submit written report to Architect.

5. Perform surveys as the work progresses to detect hazards resulting from selective demolition activities.

3.2 PREPARATION

A. Site Protection: Protect existing-to-remain sitework against damage and soiling during demolition.
   1. Do not begin selective demolition work until temporary partitions, barricades, warning signs, and other forms of protection are installed.
   2. Protect trees, plants, utilities, and existing improvements that are not to be removed from injury or damage. Replace damaged landscaping, improvements, and utilities in kind.
   3. During demolition, provide safeguards for protection of the public, Contractor's employees, and existing improvements existing-to-remain, including warning signs and lights, barricades, and the like.
   4. Provide and maintain shoring, bracing, and structural supports required to preserve stability and prevent movement, settlement, or collapse of existing-to-remain construction and finishes; and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

B. Building Protection: Protect existing-to-remain building construction against damage and soiling during selective demolition.
   1. Do not begin selective demolition work until temporary building bracing, barricades, and other protection necessary to prevent injury to people and damage to adjacent existing-to-remain facilities.
   2. Do not allow water to enter existing-to-remain wall or roof insulation. Replace insulation when it is wetted.

C. Utilities, Services, and Building Systems Protection:
   1. Maintain existing-to-remain utility services and mechanical and electrical systems and protect them against damage during selective demolition operations.
   2. Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical and electrical systems serving areas indicated for demolition.
      a. Arrange with utility companies to shut off indicated utilities.
      b. If building systems or mechanical and electrical systems are indicated as removed, relocated, or abandoned, provide temporary services and systems that bypass demolition areas and maintain continuity of services and systems to other parts of building before proceeding with selective demolition.
      c. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.

3.3 DEMOLITION

A. General Demolition Requirements:

1. Coordinate demolition to assure the proper sequence, limits, methods, and time of performance. Schedule demolition to impose minimum of hardship on present facility operations and performance of the work.
2. Conduct selective demolition and debris-removal operations to ensure the least interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
3. Demolish and remove existing construction only as shown and to the extent required by new construction. Use methods necessary to complete the work within indicated or specified limitations.
    a. Maintain existing building structure (including structural floor and roof decking) and envelope (exterior skin and framing, excluding window assemblies and nonstructural roofing material) not shown as demolished; do not demolish existing construction beyond indicated limits.
    b. Maintain existing interior nonstructural elements (interior walls, doors, floor coverings, and ceiling systems) not shown as demolished.
    c. Do not demolish existing construction beyond indicated limits.
4. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage existing-to-remain construction or adjoining construction.
5. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces.
6. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces. Verify condition and contents of hidden space before starting cutting operations.
7. Do not use cutting torches until after work areas are cleared of flammable materials. Maintain portable fire-suppression devices during flame-cutting operations.
8. Temporarily cover existing-to-remain openings.
9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
10. Do not remove any item in a manner that that results in any warranty or guarantee becoming void.

B. Special Techniques:
    1. Removed and Salvaged Items:
        a. Clean salvaged items.
        b. Pack or crate items after cleaning. Identify contents of containers.
        c. Store items in a secure area or location until delivery to the Owner.
    2. Removed and Reinstalled Items:
        a. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.
        b. Pack or crate items after cleaning and repairing. Identify contents of containers.
        c. Protect items from damage during transport and storage.

d. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.

3. Existing-to-Remain Items:
   a. When permitted by the Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.4 CORRECTION AND REPAIR

A. Damaged existing-to-remain work must be patched and repaired. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
   1. written descriptions of non-conforming, damaged, and defective work;
   2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
   3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Do not correct, repair, or replace any item in a manner that that results in any warranty or guarantee becoming void.

D. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect’s acceptance.

3.5 CLEANING

A. Except for recycled, reused, salvaged, and reinstalled items and other existing-to-remain items on Owner's property, remove demolished materials from the project site and legally dispose off-site. Do not burn demolished materials.

B. Removed items not indicated for reuse, reinstallation, or salvage are the property of the Contractor and must be cleared from the project site.
   1. Continuously clean up and clear these items; do not allow them to accumulate in the building or at the project site.
   2. Material and equipment may not be viewed by prospective purchasers nor sold on the site.
   3. The Owner is not responsible for the condition, loss, or damage to removed items.

C. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

END OF SECTION

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DIVISION 03

CONCRETE

SECTION 03 10 00 – CONCRETE FORMWORK

PART 1 - GENERAL

1.1 REFERENCES

A. General
   1. The publications listed below form a part of this specification to the extent referenced.
   2. Where a date is given for reference standards, the edition of that date shall be used. Where no date is given for reference standards, the latest edition available on the date of Notice Inviting Bids shall be used.

B. American Plywood Association (APA)

C. National Institute of Standards and Technology (NIST)
   1. NIST PS-1 U.S., Voluntary Product Standard, Structural Plywood

D. Western Wood Products Association (WWPA)
   1. WWPA Western Lumber Grading Rules

E. American Concrete Institute (ACI)
   1. ACI SP-004 Formwork for Concrete
   2. ACI 318 Building Code Requirements for Reinforced Concrete
   3. ACI 117 Specifications for Tolerances for Concrete Construction and Materials
   4. ACI 301 Specifications for Structural Concrete for Buildings
   5. ACI 347R Guide to Formwork for Concrete

F. Concrete Reinforcing Steel Institute (CRSI)
   1. Manual of Standard Practice

G. ASTM International (ASTM)
   1. ASTM C 1074 Standard Practice for Estimating Concrete Strength by the Maturity

1.2 SUBMITTALS

A. Product Data: The Contractor shall submit information on the following:
   1. Epoxy putty for use in sealing joints between panels
   2. Form release
   3. Bond preventer

B. Working Drawings

1. Submittals furnished for "Working Drawings" shall include "lift drawings" to be used for submittal of "key plans" for each related task, including reinforced concrete footings, walls, slabs on grade, columns, deck slabs, etc., for approval by the Engineer. The key plans shall include locations and dimensions of construction joints, expansion joints, and control joints, numbered in the sequence of concrete placement.
2. The approved lift drawings shall include elevations, horizontal and vertical control, dimensions, locations of penetrations, openings, and other embedded items, including electrical conduits, water stops, and joint sealants as shown on the contract drawings.
3. The approved lift drawings shall be used for calculation of loads and moments for design of concrete formwork. Drawings showing the general design, details, and dimensions of the forms proposed for construction of the structures shall be submitted for review not less than 30 days before fabrication of forms. The lift drawings shall include size, number, and location of cleanouts at the bottom of forms, as required by Section 03 30 00 and Section 03 20 00.
4. Panel sizes and panel joint locations in Class 1 and Class 2 forms.
5. Method of support for welded steel pipe, fabricated fittings, and conduits required in concrete encasement.

C. Calculations: The Contractor shall submit calculations for formwork designs that indicate the specified design loadings in combination with the allowable stresses for the materials used, the proposed construction methods, placement rates, equipment, lateral stability, and placing sequences. Calculations shall be signed and stamped by a Professional Engineer currently licensed in the State of California.

PART 2 - PRODUCTS

2.1 CLASSIFICATION

A. The specifications and drawings classify concrete formwork according to the intended final appearance or use of the finished concrete. Each classification of form has special construction requirements.
   1. Class 1: For permanently exposed interior and exterior concrete surfaces where architectural finish, as defined in Section 03 30 00, is required.
   2. Class 2: For, sumps, water passages, ceilings and interior walls, interior stairwells, underground vaults, interiors of electrical structures, tunnel linings, and other formed surfaces not otherwise specified.
   3. Class 3: For miscellaneous formed surfaces not exposed to view, such as footings, backfilled walls, and minor structures below ground surface.

2.2 DESIGN

A. The components for Class 1 forms shall be new.

B. Class 2 forms shall conform to the requirements for Class 1 forms except that the plywood may be reused. Forms for round columns shall be Class 2 and may be galvanized steel, fiberglass, laminated paper, or fiber tubes. If laminated paper, fiber, or fiberglass tubes are used, the wall thickness of the tube shall not be less than 5/16 inch.

C. Class 3 forms may be of steel or of smooth planed boards in good condition, free from large or loose knots, with tongue and groove or shiplap joints. Lagging shall be laid horizontally with all joints tight and smooth.

D. The Contractor may use steel forms instead of the Class 2 wooden forms specified in this section provided that they are approved by the Engineer as being equal to the specified wooden forms for the purpose. Surface of steel forms shall be smooth and free of dings, gouges, and other imperfections.

E. Forms shall be true in every respect to the required shape and size and shall conform to the established alignment and grades. Their strength and rigidity shall be sufficient to maintain position and shape under the loads and operations of placing and vibrating the concrete.

F. The deflection of a span of an individual component of the form shall be limited to 1/360th of the length of the span between supports, or 1/8 inch, whichever is less.

G. The camber required in the finished structure shall be as shown on the drawings. The camber required to resist deflection of the formwork imposed by construction loads or the weight of fresh concrete shall be the responsibility of the Contractor and shall be incorporated into the design of the forms.

H. Where grooves are shown on the contract drawings, they shall be formed by molding strips, or by other suitable means, as approved by the Engineer.

2.3 MATERIALS

A. Plywood
   1. New, waterproof, synthetic resin-bonded, exterior-type Douglas fir plywood, manufactured especially for concrete formwork and in accordance with NIST PS-1, Class I. Panels shall be edge-sealed.
   2. Acceptable Products: BB-Ply form, Medium Density Overlay (MDO) and High Density Overlay (HDO) produced by APA member mills. The type of plywood used shall match the surface finish of the adjacent finishes or structures, as approved by the Engineer. Matching plywood material shall be used throughout.

B. Dimension Lumber
   1. Lumber shall be new, surfaced four sides, No. 2 or better, conforming to WWPA grading rules, except as otherwise permitted in this section.
   2. Lumber from previous projects, but otherwise in accordance with the requirements of this section, may be used for Class 3 forms and for joists, stringers, beams, and shores for above-grade slab construction.

C. Structural Composite Lumber: Lumber shall be new or used, conforming to the size requirements of new surfaced dry-dimension lumber, and manufactured for use in concrete forming applications.

D. Beams, Wales, Strong backs, Stringers, and Similar Members: Steel or aluminum members, new or used; Construction Grade Lumber, Number 2 or better.

E. Metal Pan Forms: In no case shall metal pan forms be used for concrete floor construction.

2.4 ACCESSORIES

A. Form Release: Form release shall be a ready-to-use, water-based material. Release agent shall not bond with, stain, or adversely affect concrete surfaces and shall not impair subsequent treatments of concrete surfaces. The release agent shall be non-staining and shall not leave residual matter on the surface of the concrete nor adversely affect proper bonding of other surface coatings. Coating containing mineral oils or other nondrying ingredients will not be permitted.

B. Form Ties
   1. Ties shall be provided with welded steel waterstops, which shall remain embedded unless the ties are completely removable. The ties shall be constructed and removed so that no material other than steel will be left in the concrete, and no steel will be left within 1.5 inches of a concrete surface. The maximum diameter of removable cones for rod ties or other removable form tie fasteners shall not exceed 1 inch, and fasteners shall leave holes of regular shape for reaming.
   2. Twisted wire ties shall not be used for holding forms. Form ties or form-tying methods that cause spalling of the concrete when the forms are stripped or the ties removed will not be permitted.

C. Guide wires: malleable carbon steel

D. Temporary Anchorages
   1. The Contractor shall avoid drilling temporary anchors in finished concrete wherever possible unless approved by the Engineer in advance.
   2. Steel coil inserts or drop-in anchors shall be installed to leave no steel within 1.5 inches of the surface and leaving holes suitable for reaming and patching.
   3. Powder actuated fasteners, bolts and nails driven in drilled holes, lead anchors, and expansion bolt anchors will not be permitted.

PART 3 - EXECUTION

3.1 SEQUENCING AND SCHEDULING

A. A sufficient number of forms of each kind shall be provided to permit the required rate of progress to be maintained. Whenever additional forms are necessary to maintain the required progress, the additional forms shall be provided by the Contractor at Contractor's expense.

3.2 ERECTION OF FORMWORK

A. All vertical surfaces of concrete members shall be formed.
   1. The dimensions of concrete members shown on the drawings apply to formed surfaces except where otherwise indicated. Where concrete is placed directly against earth, the excavation shall be made to the dimensions shown on the drawings, plus an additional 1 inch on all surfaces where forms are omitted. The Contractor may place concrete without forms only for members where the ground can be trimmed to the required lines and will stand securely without caving or sloughing until the concrete has been placed.
   2. Sloped surfaces steeper than 4 horizontal to 1 vertical shall be provided with a top form to hold the shape of the concrete during placement.

B. Suitable and effective means shall be provided for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete. The forms shall be sufficiently tight to prevent the loss of water, cement, and fines during placing and vibrating of the concrete.

C. Forms greater than 5 feet, measured along the surface of the form in either direction, shall be provided with openings of sufficient size and spacing to permit satisfactory introduction, working, and inspection of the concrete at intervals not greater than 5 feet, unless this requirement is specifically waived by the Engineer. Adequate clean-out holes shall be provided at the bottom of each lift of forms.

D. Reentrant corners and exterior corners shall be formed with 3/4-inch fillets and 3/4-inch chamfers including formwork that is below grade unless otherwise ordered by the Engineer.

E. Plywood surfaces of forms shall be given a preliminary oil treatment by the manufacturer or shall be oiled by the Contractor at least 2 weeks in advance of its use.

F. Forms shall be coated with an approved release agent before placing of concrete. The coating shall be applied in accordance with the manufacturer's printed instructions.
   1. Excess coating shall be satisfactorily removed from forms before placing concrete. Care shall be taken to keep form release off adjacent surfaces.

2. Form release shall be removed from adjacent concrete, reinforcing steel, and other items to be embedded before concrete placement.

G. Welded-steel pipe, fabricated fittings, and conduits, required to be encased in concrete, shall be supported on concrete piers or pedestals or by other approved means. Concrete supports, if used, shall be carried to firm foundations so that no settlement of the pipe, fabricated fittings, or reinforcement cage assemblies for manhole structures or conduits will occur during construction. The tops of permanent supports shall be kept at least 6 inches from pipe, fabricated fittings, and reinforcement cage assemblies for manhole structures and conduits. Steel ties or supports may be used provided they meet the requirements of this section. Whatever the type of supports or ties used, the pipe, fabricated fittings, or conduits shall be properly secured in position to prevent floating or other movement during the placing of concrete.

3.3 INSTALLATION OF CLASS 1 FORMS

A. Class 1 forms shall be constructed with particular care to secure a quality architectural finish of uniform texture, free from visible irregularities, patch marks, and discolorations.

B. Installation of Class 1 forms shall conform to the following:
1. The edges of facing panels shall be butted tightly, and the joints shall be pointed with epoxy putty.
2. Plywood form panels shall be placed with the grain of the outer ply parallel to the direction of the span wherever possible.
3. Plywood facing shall be machine-sanded and then lightly sanded on the job as required to obtain a uniform texture over the whole area.
4. Facing panels shall be full-sized sheets of plywood except where smaller pieces will cover an entire area. Panels shall be of uniform size with joints in line vertically and horizontally. The panels shall be installed with the grain and long dimension of the plywood in the horizontal position. Concrete construction joints shall be at locations shown on the drawings or prescribed in these specifications except as expressly permitted by the Engineer.
5. Class 1 forms may be reused only with the approval of the Engineer.

3.4 REMOVAL OF FORMS

A. Forms shall be removed without injury to the surface of the finished concrete. Loads shall not be placed upon or against recently completed concrete structures until the concrete has attained its full design strength.

B. Forms for concrete encasement of pipe or fabricated fittings shall not be removed until the strength of the concrete is such that form removal will not result in spalling, peeling, perceptible cracking, breaking of edges or of surfaces, or other damage to the concrete; but not sooner than 12 hours after completion of concreting.

C. Forms for sloping surfaces shall be removed as soon as the concrete has attained sufficient stiffness to prevent sagging of the concrete.

D. Forms and falsework supporting slabs or other members that are subject to direct bending stress shall not be removed sooner than 28 days after the concrete has been placed unless concrete test cylinders show a compressive strength of at least 4,000 psi when cured under conditions similar to those affecting the structure.

E. Side forms for walls or other members not subject to dead load bending may be removed after a minimum period of 24 hours provided that satisfactory arrangements are made to cure and protect the exposed concrete.

F. Prior to removal of forms, exposed concrete shall be cured in accordance with Section 03 30 00, and forms shall be protected from increase in temperature due to ambient conditions.

G. The periods of time specified in this section for form removal are permissive only and the Contractor shall be responsible for all risks that may be involved in such removal.

H. Immediately upon removal of the forms, the concrete surfaces shall be thoroughly wetted and shall be kept wet until specific curing procedures are made effective in accordance with Section 03 30 00.

3.5 TOLERANCES

A. Tolerance limitations for all formwork and completed concrete structures shall conform to the following values except that for any element of the structure the tolerances permitted in the several categories shall not be combined to allow a total combined tolerance greater than that allowable under a single category.

1. Variation from plumb, specified batter, or specified position of structures, including the lines and surfaces of walls, piers, or vertical joint grooves: In forms, prior to placement of concrete, maximum 1/4 inch; change in position between any two points on the form shall not exceed a rate of 1/4 inch in 10 feet. In completed concrete work, maximum 1/2 inch; variation from indicated shall not exceed 3/4 inch in 40 feet.
2. Variation from the level or from the grades indicated on the drawings in slabs, horizontal joints, and tops of walls, columns or other structures: In forms, prior to placement, maximum 1/4 inch; in completed concrete work, maximum 0.375 inch; variation from indicated grades shall not exceed 1/4 inch in 10 feet.
3. Variation from the level or from the grades indicated on the drawings at weir-walls and spillway crests (excepting launder and washwater troughs): In forms, prior to placement, maximum 1/8 inch; in completed concrete work, maximum 1/4 inch; variation from indicated grades shall not exceed 1/8 inch in 10 feet unless otherwise shown on the drawings.
4. Following the removal of temporary forming, the completed concrete in its deflected shape shall in all cases conform to the requirements of ACI 117.

B. Abrupt Offsets in Formed Surfaces of Completed Concrete Work: At abutting edges of individual plywood panels, steel panels, or smooth-planed boards, 1/16 inch; at abutting edges of prefabricated form panels in a gang or continuous wall form, 1/8 inch; at construction joints that are accentuated by a groove or reveal, 1/4 inch; at construction joints that are shown to be flush across the joint, 1/8 inch.

C. Irregularities resulting from warping and variations from planeness or true curvature of lines and surfaces of walls, piers, or similar structures shall not exceed 1/4 inch when tested with a 5-foot template.

D. In totally buried structures, the preceding tolerances may be doubled.

E. Departure from cross-sectional dimensions of columns, formed beams, piers, and similar members: In forms prior to placement, ± 1/4 inch; in completed concrete work, -1/4 inch, +1/2 inch.

F. Departure from specified thickness of slabs, walls, and similar members: In forms prior to placement, ± 1/8 inch; in completed concrete work, ± 1/4 inch.

G. Where tolerances closer than those given above are necessary to accommodate the installation of any items of equipment, they shall be limited to values compatible with the equipment installation requirements.

H. For determination of compliance with specified tolerances, measurements may be made at any point on the surface of the completed concrete. For formwork tolerances, measurements may be made at any point on the surface of the form to be in contact with concrete or supporting structural members with proper allowance for the actual dimensions of such members.

3.6 FIELD QUALITY CONTROL

A. Inspection

1. The Contractor shall notify the Engineer 48 hours prior to concrete placement so that the completed formwork can be inspected and observed and inspected as necessary. Inspection of incomplete or partially completed work will not be made.
2. Inspection will be made only after all formwork, reinforcing steel, embeds, cleanouts, screeds, ties, and final adjustments have been completed by the Contractor.
3. Forms are subject to check for line, grade, plumb, and position by inspectors, surveyors, or both prior to placement of concrete.
4. Concrete shall not be placed in forms that do not meet the tolerances specified in this section.
5. The Contractor shall correct the defective work found in the inspection at least 2 hours prior to delivery of concrete.
6. Neither the review of the Contractor's drawings nor the inspection of forms by the Engineer shall relieve the Contractor of responsibility for the adequacy of the forms

nor from the necessity for remedying defects which may develop or become apparent with use.

7. The Engineer may at any time condemn a section or multiple sections of forms found deficient in any respect, and the contractor shall promptly remove the condemned forms from the work and replace them with forms meeting the requirements of the specifications.
8. Form surfaces that have been damaged and are no longer in smooth condition or that have scrapes, gouges, peeling veneer, blistered surfaces, swelling at panel edges, or similar defects shall not be used unless the Engineer approves their use in writing for surfaces to be backfilled.
9. Should any form, forming system, process, installation, or method of construction, even though previously approved for use, produce completed concrete not conforming to the requirements of these specifications, its use shall be discontinued until sufficient corrections have been made to again bring the completed work into conformance, and has been approved by the Engineer.

END OF SECTION

SECTION 03 20 00 – CONCRETE REINFORCING

PART 1 - GENERAL

1.1 REFERENCES

A. General
   1. The publications listed below form a part of this specification to the extent referenced.
   2. Where a date is given for reference standards, the edition of that date shall be used. Where no date is given for reference standards, the latest edition available on the date of Notice Inviting Bids shall be used.

B. ASTM International (ASTM)
   1. ASTM A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
   2. ASTM A706, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
   3. ASTM A1064, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

C. International Code Conference (ICC)
   1. ICC Evaluation Service reports (ICC-ES) for mechanical rebar couplers

D. American Welding Society (AWS)
   1. AWS D1.4 Structural Welding Code - Reinforcing Steel

E. Concrete Reinforcing Steel Institute (CRSI)
   1. Manual of Standard Practice

1.2 SUBMITTALS

A. Placing Drawings
   1. The Contractor shall submit complete bending diagrams, placing lists, and placing drawings for reinforcement in structures and encasements. Placing drawings shall be coordinated with Section 03 10 00 and Section 03 30 00.
   2. Placing drawings shall show all bars in their correct positions.
   3. Placing drawings shall include all information necessary for complete fabrication and placing of reinforcing steel, bar supports, splices, dowels, ties, and temporary support steel.
   4. Placing drawings shall correspond and be to the same scale as the lift drawings specified in Section 03 30 00.

B. Certificates and Test Reports: For each heat of reinforcing steel delivered to the site, the Contractor shall submit a certified copy of the mill test showing physical and chemical analysis.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Delivery, storage, and handling shall be in accordance with Owner's site specific requirements and this section.

B. Identification of Reinforcing Steel
   1. Bundles of reinforcing bars shall be tagged showing quantity, grade, size, and suitable identification to allow checking, sorting, and placing.
   2. Bundles of flat sheets and rolls of welded wire fabric shall be tagged showing quantity, style designation, width, and length.
   3. Tagging and identification requirements shall be the same for both shop- and field-fabricated reinforcing steel.
   4. Unidentified reinforcing steel will be rejected.

C. Storage and Protection: Reinforcing steel shall be adequately supported off the ground and protected from oil or other deleterious materials.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Deformed reinforcing bars shall be as indicated on the drawings in accordance with:
   1. ASTM A706, Grade 60 (weldable)
   2. ASTM A615, Grade 60, subject to the following additional requirements
      a. The actual yield strength based on mill tests shall not exceed the specified yield strength by more than 18,000 psi
      b. The ratio of the actual ultimate tensile stress to the actual yield strength shall not be less than 1.25

B. Wire and welded wire fabric shall be in accordance with ASTM A1064, Grade 65 unless otherwise noted

C. Spirals shall be fabricated as shown on the drawings, from:
   1. Wire or bars in accordance with ASTM A1064
   2. Deformed bars in accordance with ASTM A615 Grade 60

D. Concentric mechanical rebar couplers suitable for seismic applications in conformance with ACI 318 and possessing the following approvals:
   1. Current ICC-ES report

2.2 ACCESSORIES

A. Tie wire shall be 16 gauge or heavier, black annealed except as otherwise noted below.

B. Reinforcement Supports
   1. Reinforcement supports shall be cement mortar cubes wherever the finished concrete surface is continuously in contact with water.
   2. Cubes shall be of the same strength and density as the concrete in the section being placed.
   3. Metal supports, where used, shall have stainless steel tips, in accordance with CRSI MSP Class 2, Type B so that no non-stainless steel wire of the bar support lies closer than 0.75 inch to the form surface.
   4. Plastic supports and plastic-tipped supports shall not be used.

2.3 FABRICATION

A. The Contractor shall fabricate and place reinforcement in structures in accordance with the reviewed complete bending diagrams, placing lists, and placing drawings.

B. The Contractor shall cut and bend reinforcement in accordance with the reviewed fabrication details. Bars shall be bent cold. Should the Contractor elect to fabricate on the job, the Contractor shall do so in a manner and with equipment suited to the purpose and approved by the Engineer.

C. The minimum inside bend radius shall be in accordance with the requirements of Table 1 unless otherwise permitted. In addition, the beginning of the bend shall be no closer to the concrete surface than the minimum radius of the bend.

Table 1. Inside Bend Radius

Bar Size	Minimum Inside Bend Radius
No. 3 through No. 8	6 bar diameters
No. 9, 10, and 11	8 bar diameters
No. 14 and 18	10 bar diameters

PART 3 - EXECUTION

3.1 PREPARATION

A. Reinforcement shall be thoroughly cleaned of dirt, loose mill scale, excessive rust, and other substances that might reduce the bond between steel and concrete.

B. Reinforcement shall be protected from moisture until concrete is placed around it. Ends of bars that are to be left projecting from the concrete for a considerable time shall be

painted with a heavy coat of neat cement grout. Special care shall be taken to prevent disturbance of reinforcement in concrete that has already been placed.

3.2 INSTALLATION

A. The Contractor shall furnish and install the wires, metal supports, clips, and other appurtenances necessary to fulfill the requirements of the specifications.

B. Bars additional to those shown on the drawings, which may be found necessary or desirable by the Contractor for the purpose of securing reinforcement in position, shall be furnished and installed by the Contractor.

C. Except for welded splices specified in this section, welding as an aid to fabrication or installation will not be permitted except as specifically shown on the drawings or permitted in writing by the Engineer.

D. The bars shall be placed accurately in the positions with the spacings shown on the drawings and shall be securely fastened in position to prevent displacement during the placing of concrete.
   1. Templates shall be furnished for column dowels, wall dowels, and vertical steel in circular walls.
   2. Reinforcement shall be placed not closer than 2 inches to formed surfaces of concrete in contact with water, ground, or air, or not closer than 3 inches to the surfaces of concrete placed directly against the ground unless otherwise shown on the drawings.
   3. Reinforcement shall be placed not closer than 3 inches to embedded piping or sleeves passing through walls unless otherwise shown on drawings.
   4. Bundling of reinforcement may be used where shown on the drawings. Bundled bars shall be wired together securely to prevent separation during concrete placement.
   5. When necessary to move reinforcing bars to avoid interference with other reinforcement, conduits, or embedded items exceeding the specified placing tolerances, the resulting arrangement of bars shall be subject to acceptance by the Engineer.
   6. No tie wire shall remain within 1.5 inches of the surface of the concrete.

E. Reinforcing bars partially embedded in concrete shall not be field bent, except as shown on the drawings or when permitted by the Engineer.

F. Splices
   1. Bars shall be spliced only at points shown on the approved bending lists and placing drawings or where approved by the Engineer.
   2. Wherever bars are spliced, they shall be lapped the distance shown on the drawings. For bars of different sizes, the lap length shall be that given for the smaller size bar or shall be equal to the required embedment for the larger size bar, whichever is greater.

3. Bars in lapped splices shall be in contact and shall be tied in a manner that maintains bar spacing shown on the drawings.
4. Concentric mechanical rebar splices shall be of a type and manufacture approved by the jurisdictional agency for the type indicated on the structural drawings.
   a. Use mechanical rebar splices only at the locations indicated on the drawings
   b. Where not otherwise specified, use a type 2 mechanical splice capable of developing 160 percent of the specified bar yield, and 90 percent of the specified ultimate bar tension

G. Welded Splices
1. Welding of reinforcement shall be in accordance with AWS D1.4. Weld only where specifically indicated on the structural drawings and after the carbon equivalent (CE) of each component part to be welded is established
2. Special inspection is required where rebar is welded in the field.
3. Welded connections shall be provided in reinforcement assemblies where called for on the drawings or elsewhere in these specifications and at splices where the required length of lap cannot be provided and is approved by the Engineer.
4. Where bars are to be spliced by welding, the bars shall be spliced with full-penetration butt welds provided that the welding shall be done by an approved arc-welding process and shall develop 125 percent of the specified yield strength of the bar.

H. Tolerances
1. Tolerance limitations for placing reinforcement shall be as shown in Table 2.

Table 2. Tolerance Limitations for Reinforcement

Variations	Width of Cover	Tolerance Limitations
Variation from protective covering	With 2 inches cover or less	0.25 inch
Variation from protective covering	With 3 inches cover	0.5 inch
Variation from indicated spacing		0.5 inch

2. Tolerances for placement shall control over fabrication tolerances.

3.3 FIELD QUALITY CONTROL

A. Rust, seams, surface irregularities, or mill scale, except for loose rust or mill scale, will not be cause for rejection provided the weight, minimum dimensions, and height of deformations of a hand-wire-brushed test specimen are not less than the applicable ASTM specification requirements.

B. The Engineer will verify the placement of steel by survey or other measurement in the field.

END OF SECTION

SECTION 03 25 00 – CONCRETE ANCHORS IN CURED CONCRETE

PART 1 - GENERAL

1.1 REFERENCES

A. General
   1. The publications listed below form a part of this specification to the extent referenced.
   2. Where a date is given for reference standards, the edition of that date shall be used. Where no date is given for reference standards, the latest edition available on the date of Notice Inviting Bids shall be used.

B. American Concrete Institute (ACI)
   1. ACI 318, Building Code Requirements for Structural Concrete
   2. ACI 355.2, Qualification of Post-Installed Mechanical Anchors in Concrete and Commentary

C. International Code Council (ICC)
   1. Evaluation Service Report (ICC-ES)
   2. International Building Code (IBC), latest edition

1.2 SUBMITTALS

A. Product Data: The Contractor shall submit manufacturer's standard catalog data sheets. Material safety data sheets for proposed adhesives and solvents shall be submitted.

B. Test Reports and Certifications: The Contractor shall submit a manufacturer's certification verifying conformance to these specifications and that all products in contact with potable water are ANSI/NSF 61-certified.

C. Manufacturer's Instructions: Manufacturer's printed instructions for shipping, storing, mixing, and application and the applicable ICC-ES reports shall be submitted prior to delivery of the product.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Materials shall be delivered in sealed containers with labels legible and intact. Each container shall be clearly marked with the following information:
   1. Name of manufacturer
   2. Manufacturer's product identification
   3. Manufacturer's instructions for mixing

4. Warning for handling and toxicity
5. Manufacturer's batch numbers and expiration date.

B. Materials shall be stored at temperatures between 50° and 100° F unless otherwise specified by the manufacturer.

C. Materials shall be handled safely and in a manner that will avoid breaking container seals.

PART 2 - PRODUCTS

2.1 GENERAL

A. Stainless steel anchors shall be used in all applications shown on the drawings and in all cases where they will be intermittently or continuously in contact with water or in a moist environment whether or not shown on the drawings.
1. Anchors in exterior locations or damp environments shall be Type 304 or Type 316
2. Anchors in submerged locations shall be Type 316.
3. All components of stainless steel concrete anchors shall be compatible.
4. Stainless steel anchors shall be equipped with appropriate hexagon cap screws and washers or hex nuts and washers as required.

B. Anchors that are not stainless steel shall be galvanized and used only in dry interior locations.

C. The use of powder-driven anchors will not be permitted.

D. Design of anchors in concrete shall be in accordance with ACI 318 Chapter 17 and Chapter 26.7. Anchors shall comply with latest IBC, ACI-318 and ACI 355.2 in design and performance.

E. Anchors that will be subjected to seismic loads shall be designated as suitable for use in Seismic Design Categories D, E or F and shall be suitable for cracked concrete.

2.2 MECHANICAL ANCHORS

A. Mechanical expansion-type anchors will not be permitted in applications that will be subjected to vibrations or impact loads.

B. Mechanical anchors will not be permitted in locations that will be submerged in water, fluids or chemicals.

C. Substitution of specified anchors with equivalent products shall be approved by the Structural Engineer for each specific use.

D. Acceptable Mechanical Anchors installed in hardened structural concrete shall have a current ICC-ES Report:
   1. Hilti, Inc.:
      a. Kwik-Bolt TZ2 Anchors, ESR-4266
      b. Kwik HUS-EZ Screw Anchors, ESR-3027
   2. Dewalt:
      a. Power-Stud + SD1 Anchors, ESR-2966
      b. Power-Stud + SD2 Anchors, ESR-2502
   3. Simpson Strong-Tie:
      a. Strong-Bolt 2 Anchors, ESR-3037
      b. Titen HD Screw Anchors, ESR-2713
   4. Approved equal submitted for approval and approved by the Structural Engineer.

E. Temporary mechanical anchors necessary to accommodate the construction shall be of a type that is fully-removable without damage to the concrete. No steel component shall be permitted to remain in the hole after withdrawal except as approved by the Engineer. Use one of the following for temporary anchorage:
   1. One of the approved screw-type concrete anchors as specified above
   2. Other fully-removable anchor types

2.3 ADHESIVE ANCHORS

A. Adhesive for anchorage and doweling in hardened concrete shall be 2-component, insensitive to moisture. The Contractor shall use a pre-proportioned adhesive cartridge system or a pre-proportioned adhesive capsule system.

B. Adhesive shall be suitable for the environment within which it is to be installed and shall be fully compatible with the chemical and pH of the fluids in the areas of use.

C. The adhesive system shall be rated for seismic use in cracked concrete by the appropriate approval agencies.

D. Use of adhesive anchors is prohibited from use in resisting vibratory loads or when supporting overhead components and equipment where adhesive anchors are subject to pull-out under gravity loading

E. Examples of pre-qualified products (adhesive anchors) are shown in Table 1. Additional pre-approved anchor systems information may be available and can be found by contacting the Engineer. Each pre-qualified product is approved for specific service conditions as delineated in the table, and shall be used in only the conditions for which the product has passed testing.

Table 1
Pre-Qualified Adhesive Anchoring Systems

Anchor System Type	Conditions at Time of Installation	Manufacturer	Product/Approvals
Pre-Packaged 2-Component Foil Pack	Dry, damp, or water-saturated surface conditions	Hilti, Inc.	HIT-RE 500 V3 (Epoxy) ESR-3814
Pre-Packaged 2-Component Foil Pack	Dry, damp, or water-saturated surface conditions	Hilti, Inc.	HIT HY-200 V3 (Methacrylate) ESR-4868
Pre-Packaged 2-Component Foil Pack	Dry, damp, or water-saturated surface conditions	Simpson Strong-Tie	SET-XP (Epoxy) ESR-2508

2.4 DROP-IN ANCHORS

A. Application of drop-in anchors is limited to gravity supports for MEP supply lines such as ducts, conduits, and cable trays.

B. Acceptable Drop-In Anchors installed in hardened structural concrete shall have a current ICC-ES Report:
   1. Hilti HDI Expansion Anchors, ICC ESR-4236
   2. Dewalt Snake+ Anchors for cracked and uncracked concrete, ICC ESR-2272

C. Substitution of specified anchors with equivalent products shall be approved by the Structural Engineer for each specific use.

D. Installation in externally applied Fiber Reinforced Polymer (FRP) reinforcing shall not be permitted without prior approval by the Engineer.

2.5 POWER DRIVEN CONCRETE ANCHORS (SHOTPINS)

A. Application of power driven anchors is limited to minor supports for T-bar ceiling grids and partition walls sill plate anchorage unless noted otherwise on the approved construction documents.

B. Power driven anchors shall not be installed in cracked concrete.

C. Acceptable Power Driven Anchors installed in hardened structural concrete shall have a current ICC-ES Report:
   1. Hilti Power Actuated X-CC and X-CX Ceiling Clip Assemblies and X-CW Ceiling Wire Assemblies, ICC ESR-2184
   2. Hilti Low-Velocity X-U and X-U 15 Universal Power Driven Fasteners, ICC ESR-2269

3. Simpson Strong-Tie Powder-Actuated Fasteners, ICC ESR-2138
4. Dewalt Power-Driven Fasteners , ICC ESR-2024

D. Substitution of specified anchors with equivalent products shall be approved by the Structural Engineer for each specific use.

E. Do not install any power driven shot pins in the region of externally applied Fiber Reinforced Polymer (FRP) reinforcing.

PART 3 - EXECUTION

3.1 PREPARATION OF CONCRETE SURFACES

A. Concrete surfaces shall be prepared in accordance with the manufacturer's written recommendations and the requirements of the applicable ICC-ES reports.

3.2 INSTALLATION

A. Concrete anchors shall be installed in accordance with the manufacturer's written recommendations and the requirements of the applicable ICC-ES reports.

B. Protect all reinforcing steel and tendons in-place. Perform GPR, X-ray, and pachometer survey of the reinforcing steel prior to laying out the drilling locations and terminate drilling where reinforcing steel is inadvertently encountered. Drilling into existing concrete shall be performed using equipment with integral HEPA vacuum systems to control dust. Refer to approved Structural Drawing General Notes for detailed drilling requirements.

C. Adhesive anchor installation:
   1. Adhesive anchors shall be installed in concrete having a minimum age of 21 days at time of anchor installation.
   2. Fully cure all adhesive anchors in accordance with the manufacturer's instructions prior to placing adjacent concrete or loading.
   3. The first few pumps of material for adhesive anchors is not mixed properly and shall be wasted in accordance with the manufacturer. Save all wasted adhesive material for each cartridge used for inspection by the special inspector. Keep each cartridge's spoil separate
   4. Horizontal and overhead-installed adhesive anchors shall be installed by CRSI/ACI certified technicians.

D. Installation of anchors within the region of externally bonded FRP reinforcing shall not be permitted without prior approval by the Engineer.

E. Installation of anchors in prestressed concrete requires special procedures.

1. Refer to the Structural Drawings General Notes for special X-ray and shoring requirements for anchor installation in pre-tensioned concrete beams.
2. Drilling in post-tensioned beams is prohibited. Contact the Engineer prior to drilling if encountered.

3.3 CURING OF ADHESIVE MATERIALS

A. Adhesive materials shall be protected from temperature extremes during curing. The temperature of the base materials shall not exceed the range permitted for the adhesive. During hot weather, adhesive anchors shall be shaded to provide uniform curing conditions.

B. Do not place new concrete directly adjacent to adhesive anchors until the adhesive has been fully cured in accordance with the adhesive manufacturer's instructions.

3.4 FIELD QUALITY CONTROL

A. Special inspection of post-installed anchors is required in accordance with the testing program. Anchor hole drilling procedure, depth, and cleaning, wet-dry conditions, temperature, and bolt setting shall be in conformance with the manufacturer's AHJ-approved installation requirements:
   1. ICC-ES Report
   2. Verify compliance with ACI 318, Chapter 17 and Section 26.7.

B. The special inspector will inspect the concrete hole and inside surfaces prior to installation of concrete anchors to verify hole diameter, embedment, and cleaning.

C. The special inspector will perform inspections or tests on adhesive anchor installations to ensure:
   1. The adhesive has not exceeded its shelf life at time of use.
   2. The foundation or substrate has been properly prepared, cleaned, saturated, and is protected from contamination.
   3. The set time, curing time, and strength of the adhesive is in accordance with the manufacturer's specifications.
   4. The placing methods specified by the manufacturer are used.
   5. The first two to three pumps of unusable adhesive material are wasted
   6. Curing of adhesive material is initiated at the correct time and maintained for the correct time period at the proper temperature.
   7. Shims, wedges, or other leveling devices are removed, if required, and necessary repairs are made.
   8. Temperature of the substrate, bonding materials, and air are within the manufacturer's specification limits.

3.5 FIELD TESTING OF POST-INSTALLED ANCHORS

A. Contractor shall sequence the work and provide necessary access so that all necessary anchor testing can be performed in the presence of the special inspector prior to application of new concrete or finishes, or removal of scaffolding or other work platforms. A summary of the necessary post-installed anchor testing is provided below for the Contractor's reference.

B. Field-testing of installed post-installed anchors shall be performed by the Testing Company as follows, unless a higher load or testing frequency is indicated on the Structural Drawings:
   1. The testing company shall use pull or torque testing as permitted, at the proof loads indicated in the manufacturer's ICC-ES approval unless a more stringent load is listed on the Structural Drawings.
   2. At the discretion of the Structural Engineer, post-installed anchor testing may be omitted at specific difficult-to-test locations.

C. Anchor testing frequency for structural applications:
   1. For additional anchor testing frequency requirements, refer to the Structural Drawings.
   2. Unless otherwise noted on the Structural Drawings, for structural bolting and anchoring applications: Where continuous special inspection was provided during installation, test the first 10 locations for each anchor type and size, followed by 50% randomly for each bolt diameter or rebar size being used.
   3. Chemical adhesive dowels for reinforcing steel embedment:
      a. Adhesive dowels installed vertically overhead: test 100% of locations. Where continuous special inspection was provided during installation, test the first 10 locations, followed by 50% randomly for each rebar size being used.
      b. Adhesive dowels installed horizontally or vertically down: test the first 10 locations, followed by 50% randomly for each rebar size being used.
      c. Dowels for regularly spaced slab or infill shear wall reinforcing:
         1) Dowels installed overhead: test the first 10 locations, followed by 100% randomly thereafter. Where continuous special inspection was provided during installation, test the first 10 locations, followed by 50% randomly for each rebar size being used.
         2) Dowels installed downward or horizontally for conditions primarily resisting shear: test the first 10 locations, followed by 50% randomly thereafter. Where continuous special inspection was provided during installation, test the first 10 locations, followed by 25% randomly for each rebar size being used.
         3) Slabs-on-grade: test the first 3 locations, followed by 10% randomly, unless otherwise noted on the drawings.
      d. Reinforcing steel through-dowels that are continuous through existing concrete with new concrete being placed on both sides, and not necessary for stability during the construction, need not be tested.

e. Perform at least one test for each lot of adhesive.

4. Sill plate anchorage: test the first 3 locations of each anchor type, followed by 10% randomly thereafter.

D. Frequency of testing for non-structural anchorage applications: test the first 10 locations, followed by 50% randomly for each anchor type and orientation. Where continuous special inspection was provided during the anchor installation, test the first 10 locations for each anchor type and orientation, followed by 25% randomly thereafter.

1. Anchors resisting vibratory equipment loads: test all anchors.

E. If any anchor-type for any class above fails, test 100% of previously untested anchors installed that day for that class, and the next 20 locations for the anchor-type, then continue the original procedure.

F. At the Structural Engineer's discretion, pull-testing of anchors that cannot be tested due to difficulty of access in the construction may be waived or the testing methodology modified. Contact the Engineer for necessary for direction.

3.6 CLEANUP

A. Surfaces beyond the limits of the surface receiving adhesive shall be protected against spillage.

B. Adhesive applied or spilled beyond desired areas shall be immediately removed. Cleanup shall be performed with material designated by the adhesive manufacturer. Contamination of work areas shall be avoided.

END OF SECTION

SECTION 03 30 00 – CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 REFERENCES

A. General
   1. The publications listed below form a part of this specification to the extent referenced.
   2. Where a date is given for reference standards, the edition of that date shall be used. Where no date is given for reference standards, the latest edition available on the date of Notice Inviting Bids shall be used.

B. American Association of State Highway and Transportation Officials (AASHTO)
   1. AASHTO T22, Standard Method of Test for Compressive Strength of Cylindrical Concrete Specimens

C. American Concrete Institute (ACI)
   1. ACI 117, Specifications for Tolerances for Concrete Construction and Materials
   2. ACI 211.2, Standard Practice for Selecting Proportions for Structural Lightweight Concrete
   3. ACI 232.2R, Use of Fly Ash in Concrete
   4. ACI 301, Specifications for Structural Concrete
   5. ACI 318, Building Code Requirements for Structural Concrete
   6. ACI 305R, Guide to Hot Weather Concreting
   7. ACI 306R, Guide to Cold Weather Concreting

D. ASTM International (ASTM)
   1. ASTM C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field
   2. ASTM C33, Standard Specification for Concrete Aggregate
   3. ASTM C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
   4. ASTM C42, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
   5. ASTM C94, Standard Specification for Ready-Mixed Concrete
   6. ASTM C109, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-inch or 50 mm Cube Specimens)
   7. ASTM C143, Standard Test Method for Slump of Hydraulic Cement Concrete
   8. ASTM C150, Standard Specification for Portland Cement
   9. ASTM C171, Standard Specification for Sheet Materials for Curing Concrete

10. ASTM C173, Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
11. ASTM C231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
12. ASTM C260, Standard Specification for Air-Entraining Admixtures for Concrete
13. ASTM C289, Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)
14. ASTM C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
15. ASTM C330, Standard Specification for Lightweight Aggregates for Structural Concrete
16. ASTM C494, Standard Specification for Chemical Admixtures for Concrete
17. ASTM C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

E. California Building Standards Commission
   1. California Building Code (CBC)

F. California Department of Transportation (Caltrans)
   1. Standard Specifications
   2. California Test Method No. 109, Method for Testing of Material Production Plants

G. Standard Specifications for Public Works Construction (SSPWC)

1.2 SUBMITTALS

A. Product data shall be submitted as follows.
   1. Supplier of concrete and ready-mixed grout. Only one source will be approved for the Contractor, including all subcontractors. All concrete and ready-mixed grout supplied to the project shall originate from the approved single facility.
   2. Source of fine and coarse aggregate. Once approved, the source of fine or coarse aggregate shall not be changed without written approval of the Engineer.
   3. Mix designs for each strength and type of concrete proposed for use. Each mix design shall show the ingredients of the mix and shall include:
      a. Type, brand, source, and amounts of cement, pozzolans, admixtures, or other additives
      b. Source and amounts of water and aggregates
      c. Sieve analysis of coarse and fine aggregates
      d. Combined grading of each mix design
      e. Specific gravity of all materials
      f. Results of required tests
   4. Mockup panels for architectural concrete color matching

5. The Contractor shall furnish test data for fly ash showing conformance with these specifications.
6. Water: Test results.
7. Concrete Admixtures: Material specifications and instructions for use.
8. Curing Compound: Material specifications and instructions for use.
9. Bond Preventer: Material specifications and instructions for use.
10. Elastomeric Pads: Details of the types of pads to be used and methods of installing the pads.
11. Product data and certificates of compliance shall be submitted for adhesives used in repair of defective surfaces. Product data shall include mix ratio by volume.

B. Placement Drawings
1. Composite concrete placement drawings for each individual placement shall be submitted, indicating location and sizes of pipe sleeves, conduits, inserts, reglets, anchor bolts, openings, recesses, construction joints, expansion joints, and other embedded items. Placement drawings shall be coordinated with drawings required by Section 03 10 00, Concrete Formwork, and Section 03 20 00, Reinforcing Steel. Placement drawings shall show where each mix will be used.
2. The scale used shall not be less than 1/4 inch to 1 foot but shall be sufficient to adequately show all details of the construction.
3. Each drawing shall show only 1 placement. Match-lines shall reference adjoining placement drawings, and an index shall be provided on each sheet showing the location of the placement in the overall structure.
4. Rebar shop drawings in accordance with Section 03 20 00 shall accompany the placing drawings

C. Drawings for Contractor-Designed Components: Where details of equipment pedestals are not shown, drawings shall be submitted and shall meet the same requirements as placement drawings.

D. Test Reports and Certifications: The following reports and certifications shall be submitted.
1. Test results for concrete aggregates from an approved laboratory for all tests required by this section.
2. Mill test reports for cement and pozzolan.
3. Certificates of compliance for each load of cement and pozzolan.
4. Certificates of compliance for all admixtures.
5. A delivery ticket with the information stated in ASTM C94 Section 13, except actual scale weights of materials shall be furnished to the Engineer with each batch of concrete before unloading at the site.
6. A printout of the actual scale weights for all loads batched shall be submitted to the Engineer at the end of each working day.
7. Concrete permeability test results for Class V concrete.

E. Batch Plant Equipment and Procedures
   1. The Contractor shall submit the following information for an off-site batch plant:
      a. Name of supplier
      b. Plant location
      c. Plant volume or output quantity
      d. Capacity of transit equipment
      e. Estimated travel time from plant to jobsite
      f. All other data necessary to show the supplier's capability to produce concrete of the quality and quantity required
      g. Procedure for mixing and transporting the concrete to the point of placement
      h. Procedure for placement of concrete
      i. Procedures, by location, for curing concrete
      j. Method of obtaining and maintaining the required concrete temperature
      k. Method and procedure for dispensing high-range water-reducing admixture at the project site

1.3 DELIVERY, STORAGE, AND HANDLING

A. Cementitious Material: Storage bins for bulk cement and fly ash shall be waterproof and constructed so that there will be no dead storage. The capacity shall be sufficient to maintain an adequate supply at all times. Separate storage shall be provided for each cementitious material.

B. Coarse Aggregate: Coarse aggregate shall be stored separately in stockpiles or bins in advance of batch mixing. Stockpiles shall be built up by methods that prevent coning or segregation of the material. Coarse aggregate shall not be used when it becomes unsuitable because of segregation in stockpiles, excessive breakage, or because of any other reason.

C. Fine Aggregate
   1. Washed or saturated sand shall be allowed to drain for at least 24 hours, to a uniform moisture content, before batching.
   2. To prevent segregation, dry sand shall be moistened before handling.

1.4 QUALITY ASSURANCE

A. Field Samples and Mock-Ups of Architectural Concrete: Where color matching of architectural cast-in-place concrete is required, fly ash may be omitted and sand a coarse aggregate adjusted as necessary. When combined and finished as specified, concrete mix materials shall match the existing finishes as follows:
   1. Sidewalk buffer border color: provide a minimum of three different 4 feet by 2 feet mockups with color variation using the proposed mix designs as necessary to match color within 60 days of notice to proceed for seasoning and Architect color matching and approval at a later date.

PART 2 - PRODUCTS

2.1 CONCRETE

A. Concrete shall be in accordance with ASTM C94 and these specifications. If a conflict exists between ASTM C94 and these specifications, these specifications shall govern.

2.2 CEMENT

A. Portland cement shall be in accordance with ASTM C150.
   1. Type II low-alkali cement shall be used except where otherwise specified or permitted by the Engineer.
   2. Type V cement shall be used when specified for sulfate resistance.
   3. All cement of the same ASTM type shall be procured from the same mill.

2.3 POZZOLANIC MATERIALS

A. Fly ash shall be used when specified and may be used when approved by the Engineer.
   1. Fly ash shall be in accordance with ASTM C618, Class F, including all optional requirements, with the exceptions and additions listed in Table 1.

Table 1. Fly Ash Requirements

Item	Requirement
Loss on ignition	4% maximum
SO_3 content	3% maximum
Moisture content	1% maximum
R-Factor* (only required where sulfate- resistant concrete is specified) *R = $\frac{(\%CAO-5)}{\%Fe_2O_3}$ from fly ash oxide analysis	0.75% maximum

   2. Where Type V Portland cement is specified, Type II Portland cement with Class F fly ash may be used. Class F fly ash may also be used as an addition to Type V Portland cement.

2.4 WATER

A. The water and ice for curing, washing aggregate, and mixing concrete shall be clean and free from objectionable quantities of organic matter, alkali, salts, and other impurities that, in the opinion of the Engineer, might reduce the strength, durability, or otherwise adversely affect the quality of the concrete.

B. Water for curing shall not contain impurities in amounts to cause discoloration of the concrete or mortar or to produce etching of the surface.

2.5 CONCRETE AGGREGATES

A. Concrete aggregates shall be in accordance with SSPWC Section 200-1, except as noted below:
   1. Percentage wear of coarse aggregate at 500 revolutions shall not exceed 45 percent.
   2. Relative mortar strength of fine aggregate shall exceed 90 percent.

B. In addition to the requirements of SSPWC Section 200-1, concrete aggregates shall be in accordance with the following:
   1. Potential reactivity shall be evaluated using the methods described in the Appendix of ASTM C33.
   2. Aggregates shall be innocuous when tested in accordance with ASTM C289.

C. Aggregate shall not originate from the San Fernando Valley, the lower Santa Clara River below Sespe Creek, the Sespe Creek drainage areas of Southern California, or other sources susceptible to producing reactive or degenerative rock products.

D. Lightweight aggregates for structural lightweight concrete shall be in accordance with ASTM C330.

2.6 CONCRETE ADMIXTURES

A. Calcium chloride or admixtures containing added chlorides shall not be used.

B. Air-entraining admixture shall be in accordance with ASTM C260.

C. Water-reducing admixtures for concrete shall be in accordance with ASTM C494, Type A or Type D.

D. High-range water reducers shall be in accordance with ASTM C494, Type F or Type G.

E. Non-chloride accelerators shall be in accordance with ASTM C494, Type C or Type E.

F. Color Admixture for Electrical Duct Banks: The color for exterior electrical duct encasements shall be red.

1. Acceptable Products: Admixtures, Inc., Colorfull R 125; Davis Colors, Tile Red 1117; or equal.
2. The color shall be added while the concrete is being mixed, using 2 pounds of R 125 per 94 pounds of cement or 3 pounds of Tile Red 1117 per 94 pounds of cement for the class of concrete indicated.

2.7 MATERIALS FOR CURING

A. Curing compound shall be a clear membrane-forming type with a fugitive dye in accordance with ASTM C309, Type 1-D, Class B, all-resin base, except as noted in this section.
   1. When specified or approved by the Engineer, white-pigmented curing compound shall be in accordance with ASTM C309, Type 2, Class B, wax-resin base or all-resin base, except as noted in this section.
   2. Exceptions to ASTM C309:
      a. Loss of water, when tested in accordance with ASTM C309, shall not exceed 0.45 kilogram per square meter in 72 hours.
      b. Curing compound shall be ANSI/NSF 61 certified for its intended use with potable water.
   3. The Contractor shall not use curing compound where additional finishes such as hardeners, paint, and other special coatings are required.

B. Sheet Materials
   1. Sheet materials for curing concrete using the curing-blanket method shall be in accordance with ASTM C171 and this section.
   2. Polyethylene film shall be a minimum of 4 mils thick.

2.8 ACCESSORIES

A. Bond Preventer: Bond preventer shall be a nonstaining type that will provide a positive bond prevention.

B. Elastomeric Bearing Pads: Elastomeric bearing pads shall be in accordance with Caltrans Standard Specifications Section 51 1.12H(1).

2.9 ADHESIVES AND EPOXY

A. Whenever the Engineer orders repairs to be made with a 2-component, 100-percent solids epoxy resin adhesive, one of the following shall be used:
   1. Acceptable Products—non-sag, moisture-insensitive epoxy: W.R. Meadows, Rezi-Weld Gel Paste; Sika Corp., Sikadur 31; or equal.
   2. Acceptable Products—pressure-injection epoxy: W.R. Meadows, Rezi-Weld LV State; Sika Corp., Sikadur 35 Hi-Mod Epoxy; or equal.

2.10 CONCRETE MIX DESIGN

A. Mix Proportions
   1. The Contractor shall determine mix proportions within the limitations stated in this section.
   2. The materials for concrete shall be proportioned to produce a concrete capable of being deposited to obtain maximum density with maximum smoothness of surface.
   3. Ultimate compressive strength at the age of 28 days shall be not less than the value shown in Table 3.
   4. Design slump shall be in accordance with the working limit shown in Table 3. These slump limits apply before the addition of water-reducing admixtures or superplasticizers as necessary to facilitate long distance pumping and placing.
   5. Concrete mix shall have not less than the designated water-cementitious materials (w/c) ratio. Water-cementitious materials ratio (w/c) shall be determined by weight of water and Portland cement or weight of water and Portland cement plus pozzolan. Additional cement may be used to obtain a high-early-strength concrete, subject to the approval of the Engineer.
   6. Mix proportions for Class M, structural lightweight concrete, shall be determined in accordance with ACI 211.2 and these specifications.

Table 3. Concrete Requirements by Class and Use

Element	Class	Min 28 Day Strength (psi)	Working Slump	Slump Max Margin	Nominal Max Size Aggregate	Max w/c Ratio	Type
Grade Beams & Foundations	B	4,000	4 inch	1 inch	1-1/2 inch	.50	Type V NWC
Structural Slab on Grade	B	4,000	4 inch	1 inch	1 inch	.50	Type V NWC
Pre-Cast Panels & CIP Curbs	B	4,000	4 inch	1 inch	1 inch	.45	Type II NWC
CIP Walls & Columns	X	5,000	4 inch	1 inch	1 inch	.45	Type II NWC
Beams, Joists & Floor Slabs	X	5,000	4 inch	1 inch	¾ inch	.45	Type II NWC
Wet Mix Shotcrete Walls & Overlays	R	6,000	2 inch	1/2 inch	¾ inch	.42	Type II NWC
Non-Structural Site Work Concrete	A	3,000	5 inch	2 inch	¾ inch	.50	Type V NWC

Structural Lightweight Floor Fill	M	3,000	5 inch	2 inch	½ inch	.50	Type II LWC
Coarse Masonry Grout	W	2,000	8 inch	2 inch	3/8 inch	-	Type II NWC
CLSM Duct Encasement	D S	1,000 1,500	-	-	Sand	-	Type V NWC

B. Trial Batches
   1. The proposed mix design shall be evaluated from field tests of a trial batch conforming to the size of load, materials, proportions, slump, mixing and placing equipment, and procedures to be used in the actual work.
      a. The trial-batch procedure may be waived if test data of prior performance of the proposed mix design stamped by a Professional Engineer currently licensed in the State of California is presented by the Contractor, and approved by the Engineer.
   2. Ten test cylinders shall be molded from the trial batch containing the maximum water content indicated by the mix design. Five of the cylinders shall be tested at 7 days in order to establish 7-day average compressive strength information. The remaining 5 cylinders shall be tested at 28 days, and the average compressive strength of the 5 cylinders shall be at least 600 psi greater than the specified strength. The minimum strength of any 1 cylinder shall not be less than the specified strength. This requirement does not apply to the following concrete mix classes:
      a. Class D (Controlled low strength fill material, CLSM)
      b. Class R (Shotcrete)
      c. Class S (Electrical duct encasement)
      d. Class W (Masonry grout)
   3. The placing of concrete specified by compressive strength shall not begin until the mix design has qualified in accordance with the test criteria. Should the source of materials or established procedures change, new trial batches may be required.

C. Pozzolans
   1. Fly ash, as a percentage by weight of total cementitious material, shall not exceed 20 percent, unless otherwise approved by the Engineer. Fly ash used in concrete shall be from a single source and of a single class in combination with Portland cement of a single source and single type unless otherwise approved by the Engineer.
   2. Changes in source or class of pozzolan or Portland cement shall require a new evaluation by trial batch.

D. Admixtures
   1. An approved water-reducing admixture shall be used in all concrete except Class K, Class N, Class T, and Class W.

2. Water-reducing admixture shall be added to the mix in accordance with the manufacturer's printed recommendations to achieve optimum water reduction. The Engineer may allow variations in the proportions of the admixture used when variations are necessary to maintain uniform requirements under variable temperature conditions. Water-reducing admixture shall be added to the batch in the mixing water in suitable dilute form.
3. When approved by the Engineer, a high-range water-reducing admixture may be used in the mix to increase the allowable slump or to reduce the water/cement ratio. High-range water-reducing agents added at the batch plant shall be formulated to provide the extended slump retention necessary to place the concrete prior to experiencing loss of slump. High-range water reducer shall not replace required water reducer unless approved by the Engineer.
4. The air-entraining agent shall be added to provide the percentage of air entrainment in the concrete as discharged from the transit mixer shown in Table 4.

Table 4. Air Entrainment

Combined Aggregate Grading (SSPWC 201-1.3.2)	Total Air by Volume of Concrete (percent)	Maximum Aggregate Size (inches)
D and E	6±1	0.38
C	5±1	1.0
A and B	4.5±1	1.5
Structural Lightweight	5±1	0.5

5. The Engineer may rescind the approval for use of an admixture that demonstrates incompatibility with the cement or pozzolan being used on the work. A rejected admixture shall be replaced with one that demonstrates compatibility.

E. Aggregates
1. Combined aggregate gradings shall be in accordance with SSPWC Section 201-1.3.2.
2. The nominal maximum size of coarse aggregate shall be the largest practicable from the standpoint of placement of concrete and consolidation of the concrete by vibration.
3. The nominal size of an aggregate particle shall not exceed 75 percent of the smaller of the dimensions listed below in the area where it is placed.
   a. Dimension between reinforcing bars
   b. Dimension between reinforcing bars and forms
4. Grading B aggregate shall be used in all structural concrete unless otherwise specified.
5. Grading C aggregate shall be used in all other concrete mixes unless otherwise specified. No. 4 aggregate shall make up a minimum of 8 percent by absolute volume of the total aggregate and shall be included in the mix as a separate ingredient.
6. Structural Lightweight Aggregates

a. Coarse aggregate shall be lightweight aggregate not exceeding 1 inch nominal size.
b. Fine aggregate shall be natural sand.

F. Requirements by Concrete Class
1. Class B: Grading B aggregate shall be used for Class B concrete, unless otherwise approved by the Engineer.
2. Class M: Air-dry unit weight shall be 115 ± 3 pcf.
3. Class S: Electrical duct encasement concrete mixes shall use Grading D aggregate unless otherwise approved by the Engineer. Portland cement content shall not exceed 420 pounds per cubic yard. Red admixture shall be used.
4. Class W: Coarse masonry grout shall conform to the requirements of SSPWC Concrete Class 610-E-2000G.
5. Class X: Grading C aggregate shall be used unless authorized by the Engineer as necessary for long distance pumping.

G. Architectural Concrete: Where color matching of architectural cast-in-place concrete is required, fly ash may be omitted and sand a coarse aggregate adjusted as necessary.

H. Backfill slurry intended for use in footing excavation levelling shall be in accordance with SSPWC Section 201.1.1.2:
1. Tunnel Backfill: Classes 490-C-2000P or 480-C-2000
2. Trench Backfill: Class 101-E-100

2.11 SOURCE QUALITY CONTROL

A. Cement that is not in accordance with these specifications shall be promptly removed from the site.

B. Testing of Aggregates
1. Tests required to establish conformance with referenced standards shall have been performed within a period of 2 years preceding the date of submission of the material for approval. However, the following tests shall have been performed within a period of 1 month preceding the date of submission of the material for approval:
a. Sieve analysis
b. Sand equivalent
c. Cleanness value
d. Percentage wear
e. Specific gravity (SSD)

PART 3 - EXECUTION

3.1 PREPARATION

A. Immediately before placing concrete, the surfaces of foundations upon or against which the concrete is to be placed shall be free from standing water, mud, and debris. Rock surfaces shall be washed free of loose material with air-water jets. Rock and other surfaces upon or against which concrete is to be placed shall also be clean and free from oil; objectionable coatings; and loose, detached, or unsound fragments.

B. Earth surfaces shall be thoroughly moistened, but not muddied, by being sprinkled with water after they are trimmed and compacted prior to placing concrete upon them. Surfaces shall be kept moist by frequent sprinkling, as required, up to the time of placing concrete.

C. Concrete shall not be deposited under water or where water in motion may injure the surface finish of the concrete.

D. Surfaces of forms and embedded items that have been encrusted with dried mortar or grout from concrete previously placed shall be cleaned.

E. Before new concrete is placed against hardened concrete, the bonding surface of the hardened concrete shall be roughened to an amplitude of 1/4 inch using bush hammers, abrasive blasting, or high-pressure water blasting. Fresh concrete may be green-cut with water blasting and hand tools to remove laitance and spillage and to expose sound aggregate.
   1. Cleaning, roughening, or cutting shall be performed without damage to waterstops, embedments, or coatings.
   2. Earth and foreign substances shall be cleaned from the exterior of pipes by light abrasive blasting, brushing, or waterblasting; except that existing curing compound on mortar-coated pipe need not be removed. Damage to the pipe or coating caused by the Contractor's operations shall be satisfactorily repaired before concrete is placed.

F. The prepared surfaces of hardened concrete shall be kept thoroughly wet during the 24 hour period immediately prior to the placement of the new concrete. Wetting shall be accomplished by continuous sprinkling, by covering exposed surfaces with wet burlap, or by packing holes with burlap and keeping the burlap wet.

G. Where shown on the drawings or permitted by the Engineer, bond-preventer compound shall be applied by brush in accordance with the manufacturer's printed instructions.

3.2 INSTALLATION OF EMBEDDED ITEMS

A. Before concrete is placed, embedded items shall be accurately and properly placed in accordance with approved shop or erection drawings, or as directed by the Engineer. During placement of the concrete, they shall be secured against displacement with

templates or other approved methods. Items to be embedded that are incorrectly located shall be reset as directed by the Engineer. Embedded items shall be kept clear of the reinforcement. Embedded items shall have a minimum of 2 inches cover from the nearest outer surface of concrete unless otherwise required by the drawings.

B. Ferrous metalwork to be embedded in concrete shall be free of rust, loose scale, dirt, oil, grease, and other foreign substances before concrete is placed. Cleaning shall be done by metal brushes, scrapers, chisels, abrasive blasting, or grit blasting. Oil and grease shall be removed with methyl chloride or other approved solvent. The use of xylol (xylene), kerosene, or heavier petroleum solvents will not be permitted.

C. Epoxy-bonded dowels shall be installed in vinyl ester adhesive in accordance with Section 03 25 00, Concrete Anchors in Cured Concrete, unless otherwise shown on the drawings.

D. Elastomeric bearing pads shall be installed as shown on the drawings.

E. Braces inside concrete-encased welded steel pipe shall be in place before the concrete encasement is placed. The braces shall remain in place until their removal is authorized by the Engineer.

3.3 BATCHING AND MIXING OF MATERIALS

A. Batching—General
   1. Cast-in-place concrete used in the work shall be produced at a single batching plant
   2. Coarse aggregate shall be washed and, if necessary, shall be uniformly moistened just before batching. Each size of coarse aggregate shall be batched from separate bins as required to produce the combined grading requirements.

B. Batching Equipment
   1. The quantities of cement, pozzolanic materials and aggregates entering each batch of concrete shall be determined by automatic weighing. The quantity of water shall be determined by weighing or volumetric measurement. The charging of weigh hoppers directly from aggregate handling equipment such as front-end loaders will not be permitted.
   2. Facilities shall be provided to discharge the fly ash into the cement hopper only after the addition of the Portland cement. Pozzolanic materials shall be stored in such a manner as to permit ready access for the purpose of inspection and sampling and be suitably protected against contamination or moisture. Should any material show evidence of contamination or be otherwise unsuitable, the Engineer will reject it and require that it be removed from the site.
   3. The weighing equipment for aggregates shall be readily adjustable both to compensate for variation in moisture content of the aggregates and for changing concrete mix proportions. Moisture-sensing devices shall automatically compensate the aggregate weights for changes in moisture content.

4. Before weighing equipment is placed in operation, it shall be tested for accuracy by the State Bureau of Weights and Measures. A certificate of inspection shall be obtained from this agency stating the degree of accuracy of the scales. Caltrans California Test Method No. 109 certification may be used in lieu of testing by the State Bureau of Weights and Measures. In the event of damage to the scales or evidence of inaccuracy, as determined by the Engineer, the scales shall be retested, adjusted as required, and recertified.

C. Addition of Admixtures
1. Dispensers for admixtures shall have the capacity of the full quantity of the properly diluted solution required for each batch. They shall be maintained in a clean and freely operating condition. Admixtures shall be added to the premeasured water for the batch or shall be discharged into the batch by flowing automatically and uniformly into the stream of mixing water from beginning to end of its flow into the mixer. Dosing of admixtures shall be accurate to 5 percent. Equipment for measurement shall give visual confirmation of the accuracy of the measurement for each batch.
2. Prior to adding the high-range water-reducing admixture at the jobsite, slump shall not exceed the working limit. The high-range water-reducing admixture shall be accurately measured and pressure-injected into the mixer as a single dose by an experienced technician. The field dispensing system shall conform to the same requirements as a plant system, and a standby dispensing system shall be provided and tested prior to each day's operation of the jobsite system. After the addition of the high-range water reducer, the concrete shall be mixed at mixing speed for a minimum of 5 minutes.
3. High-range water-reducing admixture shall be dispensed at the batch plant as part of the normal batching cycle.

D. Mixing—General
1. The Engineer may increase the mixing time when the charging and mixing operations fail to produce a delivered batch in which variations of consistency, mix, or grading are within the limits specified.
2. Variations in consistency during discharge of a single batch shall not exceed 1 inch of slump, except that a greater variation will be permitted if the slump of the concrete decreases and no water is added. Variations in mix and in grading of different parts of the delivered batch shall be within the limits stated in ASTM C94.
3. Water shall be introduced prior to, during, and following mixer-charging operations.
4. When a mixer produces unsatisfactory results, it shall be repaired promptly and effectively, or it shall be replaced. Mixers shall not be loaded in excess of their rated capacity.
5. Overmixing, such as to require addition of water to preserve the required consistency, will not be permitted.

E. Transit Mixing
1. Transit mixers shall be in accordance with ASTM C94.

2. Truck mixers and their operation shall ensure that the discharged concrete is uniformly within acceptable limits of consistency, mix, and grading. All mechanical details of the mixer, such as water-measuring and discharge apparatus, condition of the blades, speed of rotation, general mechanical condition of the unit, and clearance of the drum shall be checked before use of the unit will be permitted.
3. Truck mixers shall be equipped with approved revolution counters by which the number of revolutions of the drum or blades may readily be verified. The water-tank system of the truck shall be equipped with gauges that permit accurate determination of the tank contents.
4. Each batch of concrete shall be mixed in a truck mixer for not less than 80 revolutions of the drum or blades and at the rate of rotation designated as mixing speed by the manufacturer of the equipment. Additional mixing, if any, shall be at the speed designated as the agitating speed by the manufacturer of the equipment. All materials, including mixing water but excepting high-range water reducers, shall be in the mixer drum before actuating the revolution counter for determining the number of revolutions of mixing.

F. Centralized Batch Mixers
1. Centralized batching and mixing plants shall have a stationary mixer of 12 cubic yards minimum capacity.
2. Mixers in centralized batching and mixing plants shall be arranged so that mixing action can be observed from a location convenient to the mixing-plant operator's station.
3. Concrete ingredients shall be mixed for not less than 1-1/2 minutes after all the ingredients, except the full quantity of water, are in the mixer.
4. Each stationary mixer shall be equipped with a mechanically operated timing and signaling device that will indicate and ensure the completion of the required mixing period and will count the batches.

3.4 TRANSPORTATION

A. The methods and equipment used for transporting concrete to the site of work and the time that elapses during transportation shall not cause segregation of coarse aggregate or slump loss in excess of 1 inch when measured at the point of discharge. Only agitating equipment shall be used to transport concrete on roads or rails.

B. Nonagitating equipment for transporting concrete will not be permitted.

3.5 METHODS OF PLACEMENT

A. Conveyor Belts and Chutes
1. Ends of chutes, hopper gates, and other points of concrete discharge throughout the conveying, hoisting, and placing system shall be designed and arranged so that concrete passing from them will not fall separated into whatever receptacle

immediately receives it. Adequate headroom provision must be made at such points for a vertical drop and for proper baffling.

2. Chutes or conveyor belts shall not be used except as approved by the Engineer. Chutes longer than 50 feet and conveyor belts longer than 110 feet will not be permitted.
3. The minimum slope of chutes shall enable concrete of the specified consistency to readily flow. If a conveyor belt is used, it shall be wiped clean by a device operated so that none of the mortar adhering to the belt will be wasted.

B. Pumping of Concrete

1. The type and operation of a concrete pump or of pneumatic or other type of placing equipment shall be subject to the approval of the Engineer. The equipment used in placing the concrete and the method of its operation shall introduce the concrete into the forms without high velocity. Placing equipment shall be operated only by experienced operators.
2. During pumping, the Contractor shall have on-site a standby placing system, acceptable to the Engineer, to ensure that in the event of breakdown of the primary placing equipment, the concrete placement can continue without cold joints.
3. The minimum diameter of the hose or conduit shall be 4 inches unless otherwise approved by the Engineer. Aluminum conduits shall not be used for conveying the concrete. Pumping equipment, hoses, and conduits that are not functioning properly shall be replaced.
4. If, in the Engineer's opinion, the equipment and pumped concrete are not satisfactory, the Contractor shall discontinue the pumping operation and shall place concrete using other methods approved by the Engineer.

3.6 PLACING CONCRETE

A. Concrete shall not be placed until the sequence of concrete placement and the number, type, position, and design of construction joints and expansion joints has been approved by the Engineer.

B. Construction Joints

1. A transverse construction joint with a roughened face shall be provided at the end of a continuous placement.
2. Where placing concrete is interrupted long enough for the concrete to take its initial set, the working face shall be made a construction joint.

C. Joints

1. The shape and dimensions of keys shall be as detailed on the drawings and as specified.
2. The profile of the roughened joint shall be approximately 1/4 inch, and shall be uniform over the entire area of the construction joint.
3. Bulkhead joints shall be plumb, except where sloping slabs intersect walls or columns. Bulkhead joints shall be keyed and roughened.

4. Horizontal joints shall be straight, level, and roughened.
5. Joint tolerances shall be in accordance with Section 03 10 00.
6. A formed keyway shall be provided at vertical construction joints.

D. Sequence of Placing
1. Joints shall be vertical in walls and horizontal in slabs.
2. The Contractor shall alternate placement of slab, wall, roof, or other areas to allow for strength gain and volume change to take place.
3. Construction joints for controlling shrinkage shall be provided in floor slabs, walls, decks, conduits, and channels.
4. Intermediate slabs and wall sections shall not be placed until 7 days after the adjoining slabs and walls have been placed.
5. Corner sections of walls shall not be placed until the adjoining wall sections shall have cured at least 14 days.
6. Joints in slabs shall align with joints in adjoining walls unless otherwise approved by the Engineer or shown on the drawings.
7. Sections for concrete channel lining shall be placed in staggered fashion, unless slipform construction is approved by the Engineer.
8. Subsequent placements of mass concrete shall not occur until previous placement has been cured for 7 days.

E. Concrete shall be placed at the job within 1-1/2 hours after the water has been added to the cement and aggregates, and prior to stiffening or initial set. There shall be no segregation or loss of ingredients during placement.

F. Starter walls shall not be used unless shown on the drawings or approved by the Engineer.

G. At least 2 hours shall elapse after depositing concrete in long or high columns and walls before depositing in beams, girders, or slabs supported thereon. For columns and walls, 10 feet or less in height, the Contractor shall wait at least 45 minutes prior to depositing concrete in beams, girders, brackets, column capitals, or slabs supported on them. Beams, girders, brackets, column capitals, and haunches shall be considered as part of the floor or roof system and shall be placed monolithically with them.

H. Placement Size
1. When not otherwise shown or specified, concrete slabs shall be constructed in segments not larger than 30 feet by 30 feet.
2. The long dimension of the slab panel shall not exceed 1-1/2 times the short dimension unless otherwise approved by the Engineer.
3. Walls shall be constructed in segments no longer than 30 feet.
4. Continuous placement of mass concrete, Class L, shall not exceed [400] cubic yards.

I. Weather

1. Placing of concrete will not be permitted during rainfall or when rain appears imminent. If rain should fall subsequent to placement, the concrete shall be completely protected until curing is complete.
2. Concrete shall not be placed on frozen ground nor mixed or placed when the temperature is 40°F or less and dropping, and the possibility of freezing is indicated by U.S. Weather Bureau frost warnings.

J. Free fall of concrete shall not exceed 4 feet. The horizontal movement of concrete in the forms shall not exceed 5 feet. Concrete shall not be dropped through reinforcement. Mortar shall not accumulate on form surfaces above the placed concrete. Hoppers, tremies, pump line, ducts, chutes, or other methods approved by the Engineer shall be used to deposit the concrete in its final position within the specified limits and without segregation of the mix.

K. Except as intercepted by joints, concrete shall be placed in continuous, approximately horizontal layers. The depths of layers shall not exceed 20 inches. Succeeding layers shall be placed while the previous layer is still plastic. Cold joints will not be permitted. Concrete placement shall begin at the lowest point in each section of concrete to be placed.

L. Temperature
1. Except for mass concrete, the temperature of concrete as placed shall not be more than 85°F. When the temperature of the materials or the probability of increase in ambient air temperature indicates a temperature of concrete, as placed, above 85°F, the Contractor shall maintain the temperature of concrete within the specified limits by precooling aggregates and mixing water, using ice to cool the mixing water, shading aggregates, or placing at a time of day when the ingredients will not produce concrete above 85°F. Wetting of aggregates for cooling shall be performed sufficiently in advance of delivery into the batching plant bins and in such manner that the batched material will have a uniform and stable moisture content.
2. Contractor shall submit the proposed method of obtaining and maintaining the required concrete temperature.

M. Consistency
1. With a normal mixing period and in the judgment of the Engineer, the quantity of water entering into a batch of concrete shall be just sufficient to produce a concrete that can be worked properly into place without segregation and that can be compacted to give the desired density, impermeability, and smoothness of surface. With variations in the nature or moisture content of the aggregate, the quantity of water shall be changed to uniformly produce the desired consistency.
2. Retempering concrete or mortar will not be permitted. Concrete or mortar that has stiffened so that proper placement and consolidation cannot be ensured shall be wasted.
3. Immediately prior to placing, the slump of the concrete shall be in accordance with the limits in Table 3. The slump shall be measured in accordance with ASTM C143.

4. The working limit in Table 3 is the maximum slump permissible for estimating the quantity of mixing water to be used in the concrete. The inadvertent margin is the allowable deviation from the working limit for such occasional batches of concrete as may inadvertently exceed the working limit. Batches of concrete with slumps exceeding the working limit will be rejected if the frequency of their occurrence, as determined by the Engineer, is excessive. Concrete with a slump exceeding the values defined in the rejection limit column shall not be used for the work. Concrete that has been rejected for failure to meet slump limits shall not be salvaged for use in the work. Increased mixing time, addition of dry materials, or similar modifications of a rejected batch for the purpose of conforming to slump limits will not be permitted.

3.7 CONSOLIDATION

A. All concrete, including lean concrete and backfill slurry, shall be consolidated with internal vibrators having a frequency of at least 9000 vibrations per minute and an amplitude adequate to consolidate the concrete in the section being placed.

B. The forms shall contain sufficient windows or shall be limited in height to allow visual observation of the concrete during placement. Sufficient illumination shall be provided in the interior of forms so that at the places of deposit the concrete shall be visible from the deck or runway.

C. Concrete shall be consolidated by vibration to the maximum practicable density. The concrete shall be free from pockets of coarse aggregate and entrapped air and shall close snugly against the surfaces of forms and embedded materials. In consolidating each layer of concrete, the vibrator shall be operated at regular and frequent intervals and in as nearly a vertical position as practicable.

D. The vibrating head shall penetrate into the preceding layer 6 to 8 inches and then be withdrawn at a slow rate. The top part of each layer shall be re-vibrated systematically at the latest time the concrete can be made plastic by means of vibration. Concrete shall not be placed until the previous layer has been vibrated. The vibrating head shall not contact the surfaces of the forms. The use of vibrators for shifting or dragging concrete will not be permitted.

E. Unless directed otherwise by the Engineer, the top 2 feet of walls shall be re-vibrated approximately 1 hour after placement of concrete and while a running vibrator will still sink under its own weight into the concrete and liquefy it momentarily. At least one standby vibrator in operable condition shall be at the placement site prior to placing the concrete.

F. The number of vibrators employed shall be sufficient to consolidate the concrete within 15 minutes after it is deposited in the forms.

3.8 FINISHING OF CONCRETE SURFACES

A. Finishing and patching of concrete surfaces shall be performed by skilled concrete finishers. The Contractor shall advise the Engineer when concrete finishing will be performed.

B. Finished formed surfaces shall conform accurately to the shape, alignment, grades, and sections shown on the drawings or prescribed by the Engineer. The surfaces shall be free from fins, bulges, ridges, honeycombing, or roughness of any kind and shall present a finished, smooth, continuous, hard surface.

C. Concrete repairs and partial replacement work:
   1. Structural concrete surfaces and flatwork, whether visible or not, shall match the existing directly adjacent concrete finishes in texture, color, quality, and uniformity as much as is practicable.
   2. Architectural Concrete surfaces that will be visible after the completion of construction shall match the existing directly adjacent concrete finishes in texture, color, quality, and uniformity as much as is practicable. The finish of this concrete is subject to preparation of mock-up panels and acceptance by the Architect:

D. External corners shall be rounded or beveled.

E. As soon as forms are removed, exposed surfaces shall be carefully examined and irregularities shall be immediately rubbed or ground to secure a smooth, uniform, and continuous surface. Surfaces to be smoothed shall not be plastered or coated. Repairs shall not be made until the surface has been inspected by the Engineer.

F. On areas requiring treatment of defects and until such treatment has been completed, only water cure will be permitted.

G. Defective surfaces shall be cut back a minimum of 1/2 inch over the entire area. Featheredges will not be permitted. Unless chipping or cutting tools are required to deepen the area, the surface shall be prepared by abrasive blasting to a minimum depth of 1/32 inch into sound concrete. Laitance and soft material shall be removed.

H. After cutting or abrasive blasting, the surfaces shall be moistened in advance of placing repair material.

I. Defects greater than 1 square foot in area shall be repaired with pneumatically placed concrete or with mortar in accordance with Section 03 60 00, Grout and Dry-Pack.

J. For hand repairs, the material used shall be a Portland cement grout in accordance with Section 03 60 00, Grout and Dry-Pack. On exposed work, the color of the patch shall match the color of the surrounding concrete.

K. Surface and near-surface air voids shall be filled with dry-packed mortar in accordance with Section 03 60 00, or they shall be removed and repaired. Honeycombed concrete

shall be removed and replaced. Repairs and replacements shall be promptly executed while the base concrete is still uncured.

L. Holes left by form ties or other imperfections having a depth greater than their least surface dimension shall be reamed and repaired with dry-pack mortar in accordance with Section 03 60 00.

M. Repairs shall fully bond to the concrete substrate. Adhesives or bonding agents shall not be used unless specifically ordered by the Engineer. Surfaces of repairs shall match the finish of the surrounding concrete and shall receive the same curing treatment as the surrounding concrete. When tapped with a hammer, repaired areas shall not produce a hollow sound.

N. When the Engineer orders repairs to be made with polymer modified grout, the grout shall be in accordance with Section 03 60 00.

O. At any time prior to final acceptance, concrete found to be defective, damaged, or not in accordance with the specifications shall be repaired or removed and replaced with acceptable concrete.

3.9 ARCHITECTURAL FINISH

A. Where specifically shown on the drawings, a final architectural finish shall be applied on permanently exposed portions of reinforced concrete structures above finish grades and waterlines except on minor drainage structures and curbs.

B. Immediately after forms are stripped, concrete surfaces shall be inspected; joint defects, voids, rock pockets, or other defective areas shall be repaired; and holes for form tie fasteners shall be filled. The application of architectural finish shall not start until all preparatory work, including the removal of dirt, grease, and curing compound, is complete.

C. Application of Architectural Finish
   1. Surface shall be brush abrasive blasted prior to applying architectural finish.
   2. The brush abrasive blast surface shall be wetted and a grout shall be applied. The grout shall be made by mixing 1 part cement and 1.5 parts fine sand with sufficient water to give it the consistency of thick paint. The cement used in this grout shall be either 100 percent gray Portland cement or a mixture of gray with proportions of white Portland cement up to 60 percent. The freshly applied grout shall be vigorously rubbed into the concrete surface with a wood or rubber float, filling all pits in the surface.
   3. After application of the grout, the surface shall be kept moist for a minimum of 1 hour or until the grout hardens sufficiently so that it can be scraped from the surface with the edge of a steel trowel without disturbing grout in the hole. The grout shall then be removed with a steel trowel and the surface shall be allowed to dry.

4. When dry, the surface shall be vigorously rubbed with burlap to completely remove grout. The entire operation for an area shall be terminated at panel points and shall be completed the day it is started. Grout shall not be left on the surface overnight.
5. The desired effect shall be a light-colored concrete surface of uniform color and texture, with no appearance of a paint or grout film. Defective architectural finish shall be rubbed down with carborundum bricks as directed by the Engineer.
6. Architecturally treated concrete surfaces shall match the approved sample in texture, color, and quality.

3.10 FINISHING UNFORMED SURFACES

A. A steel-trowel finish shall be provided on unformed concrete surfaces unless otherwise specified.

B. Unless otherwise shown on the drawings, floors, walkways, and roof surfaces shall be sloped a minimum of 1/8 inch per foot to drain water.

C. The following will not be permitted on slab or floor finishes:
   1. Dusting dry cement or sand on the surface to absorb excess moisture
   2. Use of a mortar finishing coat
   3. Excessive troweling or manipulation that brings water or a large amount of fines to the surface
   4. Use of a Fresno
   5. Addition of water to the surface during the finishing operation
   6. Use of the floor during construction in a manner that leads to marring or staining the finish

D. Steel-Trowel Finish
   1. The concrete shall be brought up evenly to slightly above finished grade and shall be thoroughly compacted. The top shall be struck off to accurately established grade strips or grade blocks and the surface shall be floated to bring just enough mortar to the surface for troweling.
   2. As soon as the moisture sheen has disappeared from the floated surface and the concrete has hardened sufficiently to prevent drawing moisture and fine materials to the surface, the surface shall be steel troweled to produce a smooth, hard, uniform finish. Machine finishing may be used for the initial troweling. A final steel hand troweling shall be given after the concrete is hard enough that no mortar accumulates on the trowel when manipulated with heavy pressure.
   3. Exposed interior horizontal concrete floors, except water-contact surfaces or underside of slabs, shall be treated with a chemical hardener. Hardener shall be applied in accordance with the manufacturer's printed instructions, but in no case shall the number of applications be fewer than 3.

E. Wood-Float Finish

1. The concrete shall be brought up evenly to slightly above finished grade and shall be thoroughly compacted. The top shall be struck off to accurately established grade strips or grade blocks and the surface shall be floated.
2. As soon as the moisture sheen has disappeared from the surface and the concrete has hardened sufficiently to prevent drawing moisture and fine materials to the surface, a wood float shall be used to provide a uniform finish. Machine finishing may be substituted for a wood float finish.
3. A wood float finish shall be provided on the following surfaces:
   a. Concrete roof slabs
   b. The top of unformed surfaces at filter underdrains where grout is applied
   c. Unformed surfaces of miscellaneous concrete structures not subject to foot traffic, not in contact with flowing water, or not exposed to view

F. Slip-Resistant Surfaces
1. On steps, landings, and 12 inches out onto concrete floor areas at top and bottom of stairways, 1/4 pound of non-slip aggregate per square foot of surface shall be applied immediately after floating. The aggregate shall be worked into the surface during steel-trowel finishing. After the floor has hardened, the surface shall be ground or scrubbed with steel wool to remove the cement film and to expose the non-slip aggregate.
2. Broom Finish
   a. At locations subject to light traffic, where a non-slip aggregate is not specified, the final troweling shall be omitted and a broom finish shall be provided. The surface shall be roughened by drawing a broom over the surface. Steel-tined brooms shall be used to produce a heavy broom finish.
   b. A broom finish shall be provided on sidewalks, walkways, and other surfaces subject to light traffic.
   c. A heavy broom finish shall be provided on ramps, loading docks, and chemical storage areas.

3.11 EPOXY REPAIR OF DEFECTIVE SURFACES

A. Surface preparation and application of epoxy shall be in accordance with the manufacturer's written instructions. Epoxy repairs shall be sound and free from shrinkage, cracks, and drummy areas after the fillings have been cured and have dried at least 30 days.

B. Application by pressure injection shall be in accordance with the manufacturer's written instructions. The method of injection of epoxy resin shall be subject to the approval of the Engineer.

3.12 CONCRETE CURING

A. Surfaces of newly placed concrete shall be cured using the wet-burlap-mat method or the water-spray method. The Contractor may use the curing-compound method subject to

approval of the Engineer. When approved by the Engineer, the curing-blanket or sheet-materials methods may be used for curing of the tops of slabs.

1. Construction joints to which subsequently placed concrete is to adhere shall be water-cured until they are covered with concrete. Curing compound shall not be applied to the surfaces of these construction joints. Concrete surfaces to receive bond preventing material shall be water-cured until application of the bond preventing material.
2. The surface to be cured shall be kept continuously and completely wet during the specified curing period whenever any water-curing method is used.

B. Wet-Burlap-Mat Method: Surfaces shall be thoroughly wetted and covered with wet burlap mats as soon as the forms have been stripped or as soon as the concrete has set sufficiently to avoid marring the surface. Thereafter, the burlap and the concrete surface shall be continuously kept wet for 14 days.

C. Water-Spray Method
1. Surfaces shall be tightly closed off by bulkheads, tight enclosures, or other means, and the surfaces shall be kept moist by sprinkling or by a spray system for 14 days immediately following the removal of forms or surface finishing.

D. Curing-Compound Method
1. Surfaces shall be sprayed uniformly with 2 coats of curing compound. Each coat shall provide a minimum coverage of 1 gallon per 250 square feet of surface. As soon as the first coat has become dry, a second coat shall be applied in the same manner. The direction of application of the second coat shall be perpendicular to the first coat. The curing compound shall be sprayed using approved pneumatic or pump-driven equipment having the following characteristics:
   a. Separate lines to the nozzle for material and for compressed air
   b. A filtering system for the removal or entrapment of contaminants
   c. A constant application pressure
2. When used on an unformed concrete surface, application of the first coat of curing compound shall commence immediately after finishing operations have been completed. When curing compound is used on a formed concrete surface, the surface shall first be moistened with a fine spray of water immediately after the forms have been removed. The spray shall be continued until the surface does not readily absorb further water. As soon as the surface film of water has disappeared and the surface is almost dry, the first coat of curing compound shall be applied. In the event that application is delayed on either formed or unformed surfaces, the surface shall be kept continuously moist until the compound has been applied or the specified period of water curing has elapsed.
3. The Contractor shall allow no traffic and take precautions to avoid damage to the membrane of the curing compound for a period of not less than 28 days. Damage shall be repaired immediately to the satisfaction of the Engineer.
4. Curing compound shall not be diluted by the addition of solvents or thinners, nor shall it be altered in any other manner. Curing compound that has become chilled and is too viscous for satisfactory application shall be heated by steam or hot water

bath until it has proper fluidity. The temperature of the compound shall not exceed 100°F. Curing compound shall not be heated by direct exposure of the container to fire.

E. Curing-Blanket or Sheet-Materials Method
   1. Surfaces shall be thoroughly wetted and then covered as soon as the concrete has set sufficiently to avoid marring the surface. The curing blankets or sheet materials shall remain in place for 14 days. Should the curing blankets or sheet materials become torn or otherwise ineffective, the damaged sections of the sheeting materials shall be replaced.
   2. Waterproof paper shall be laid either with the edges butted together and the joints sealed with 2-inch-wide strips of sealing tape or with the edges lapped not less than 3 inches and fastened together with waterproof cement to form continuous watertight joints.
   3. Polyethylene sheets shall be laid with edges butted together and the joints sealed with 1 inch-wide strips of acetate tape.
   4. White burlap-polyethylene sheeting shall be laid with the wetted burlap in contact with the concrete. The polyethylene layer shall be sealed at the joints using 1-inch-wide strips of acetate tape.
   5. During the curing period, traffic or depositing of objects will not be permitted on the curing blankets or sheet materials.

3.13 TOLERANCES

A. Tolerances shall be in accordance with ACI 117 and Section 03 10 00.

3.14 FIELD QUALITY CONTROL

A. The Engineer will perform tests and inspections to determine compliance with these specifications. The Contractor shall cooperate in making these tests and inspections by furnishing necessary labor to assist the Engineer in obtaining, handling, protecting, and curing samples at the jobsite. The Contractor shall provide adequate facilities for storage and curing of concrete test cylinders on the site.
   1. A compressive strength test will consist of the average strength of 2 cylinders fabricated from a single load of concrete, except that if any cylinder shows evidence of improper handling, molding, or testing, it will be discarded and the strength test will consist of the strength of the remaining cylinder.
   2. The frequency of sampling will be determined by the Engineer.
   3. Concrete compressive strength tests representing concrete that has been placed shall attain the specified strength evaluated as follows: The average of all sets of 3 consecutive strength tests shall be equal to or greater than the specified strength. Not more than 10 percent of the tests shall be less than the specified strength. No individual test shall be more than 500 psi below the specified strength.
   4. Concrete that is represented by compressive strength tests and that fails to meet the requirements of this section shall be removed from the work. However, the concrete

represented by the failing compressive strength tests may be tested in place for strength. The Engineer will determine the method to be used for testing in place. When drilled cores are to be used to verify the in-place strength, they will have a nominal diameter of 4 inches and will be obtained and tested in accordance with ASTM C42, unless otherwise determined by the Engineer. A minimum of 3 cores will be taken in each area represented by the failing compressive strength tests. If each core produces compressive strength test results 85 percent or greater than the specified compressive strength, the concrete represented may be accepted with no further action required. The Contractor shall repair areas damaged by coring.

5. Compressive strength will be determined by testing fabricated 6 inch by 12 inch cylinders that have been cured in accordance with ASTM C31. The cylinders will be tested in accordance with AASHTO T 22 or ASTM C39.
6. Air content will be determined in accordance with ASTM C231 or ASTM C173.
7. Air content of concrete containing lightweight aggregates will be determined in accordance with ASTM C173.
8. Unit weight of structural lightweight concrete will be determined in accordance with ASTM C567.
9. The aggregate and concrete mixes used shall be changed whenever, in the opinion of the Engineer, change is necessary or desirable to secure the required workability, density, impermeability, surface finish, and strength.
10. Curing compound will be subject to sampling and testing by the Engineer.
11. Chloride permeability will be determined by testing fabricated 4-inch by 8-inch cylinders or 4-inch-diameter cores that have been cured in accordance with ASTM C31. The cylinders will be final cured through their 56-day age and then tested in accordance with ASTM C1202.

B. Plant Inspection
   1. The Contractor shall provide acceptable facilities at the batching and mixing plant for obtaining samples of materials used in the concrete, as requested by the Engineer.

C. Field Inspection
   1. Unless this requirement is specifically waived, the Engineer will inspect formwork prior to the placement of concrete. The Contractor shall notify the Engineer at least 7 days in advance with confirmation in 72 hours of necessary inspections and concrete placements. Prior to notification, work shall be complete and ready for inspection on that portion of the work where concrete is to be placed. Defective or incomplete work discovered by the Engineer shall be corrected in a timely fashion to allow for reinspection and further corrective action if necessary. Corrective work shall be completed a minimum of 2 hours prior to delivery of concrete.
   2. Unless this requirement is specifically waived, the Engineer will provide a written list of deficiencies noted during each inspection. Deficiencies shall be corrected prior to scheduling reinspection unless this requirement is specifically waived by the Engineer.

3. Concrete shall not be placed until all formwork, installation of embedded items, and preparation of surfaces involved in the placing have been inspected and approved by the Engineer.

3.15 PROTECTION

A. When concrete slab or other unformed concrete is placed under warm, dry, dusty, or windy conditions, concrete surfaces shall be protected from rapid drying by use of windbreaks, shading, fogging with properly designed nozzles, or a combination of these methods. Dust control shall be provided in the surrounding areas during placement. Similar protective measures, except fogging, shall be provided on conveyor belts and chutes. If, in the opinion of the Engineer, these conditions are not satisfactorily met, concrete shall not be placed.

B. Hot weather concreting procedures provided in ACI 305R shall be used when ambient conditions dictate.

C. Cold weather concreting procedures provided in ACI 306R shall be used when ambient conditions dictate.

D. Concrete shall be protected against damage until final acceptance by the Engineer. Special care shall be taken to prevent the concrete from drying out during the curing period and to avoid damaging the surfaces.

E. The finish of exposed interior concrete floors shall be protected from damage, scuffing or marks. Equipment used on floor shall have white wheels, or the floor shall be protected to avoid tire marks and darkening of the concrete.

F. Precautions shall be taken to prevent overloading floors, beams, and other members. The Contractor shall comply with the Engineer's instructions regarding the loads that will be permitted on these members during construction.

END OF SECTION

SECTION 03 54 16 – HYDRAULIC CEMENT UNDERLAYMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Hydraulic cement underlayment.
   2. Patching material.
   3. Surface preparation.
   4. Installation materials.
   5. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

B. Related Requirements:
   1. Section 09 05 16 for preparation of concrete slabs for finish flooring; and for remedial MVER products.

1.2 REFERENCES

A. Definitions:
   1. Manufacturer: Means the cement underlayment manufacturer, unless otherwise indicated.
   2. Underlayment: Means a material installed over subfloors to help achieve specified floor flatness values, and to smooth and correct surface irregularities prior to flooring installation

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Verify chemical and adhesive compatibility of selected cement underlayment with installed curing compounds and installed moisture vapor emission control systems, based on current product formulations.
   2. Proposed substitution requests and submittals that change the quality (grade) or the generic chemistry of specified cement underlayment are prohibited and returned to the Contractor without review or responsive action, except to record non-conformance with this requirement.
   3. Coordinate existing concrete subfloor surface flatness and levelness with ACI 117 requirements, measured in conformance with ASTM E 1155 (3D laser scanning or Allen Face F-Meter methods), and tolerances required, recommended, or accepted by the cement underlayment manufacturer.

4. Coordinate cement underlayment primers with concrete curing compounds.
   a. When accepted in writing by the manufacturer's field representative, specified cement underlayment may be applied over concrete slabs treated with either a silicate or acrylic resin curing compound.
   b. Wax- and petroleum-based emulsions are permanent bond breakers that must be completely removed by mechanical means prior to patching or leveling.
   c. Dissipating compounds must be completely removed by mechanical means prior to patching or leveling.
   d. In all cases, acid etching, adhesive removers, solvents, and sweeping compounds are prohibited.
5. When covering plywood or OSB subfloor sheathing with cement underlayment, additional measures must be taken to avoid concrete topping or concrete mix water leaching into subflooring. (concrete topping and concrete toppings seal the upper surface and moisture must travel through the full depth of subflooring to escape, which may delay ceiling finish installation to avoid trapping moisture within the assembly)
6. Specified coverage rates and thicknesses are minimum. If manufacturer's recommended coverage rates differ from specified rates, then
   a. consult the manufacturer's representative and obtain manufacturer-recommended coverage rates printed on manufacturer's letterhead;
   b. assume the manufacturer-recommended coverage rates govern; and
   c. promptly submit an RFI to the Architect for resolution; include manufacturer-recommended coverage rates with the RFI.

B. Sequencing:
1. Install cement underlayment only after concrete is cured to a condition of equilibrium; is sufficiently dry to bond with cement underlayment; and has alkalinity (pH), MVER, and RH within ranges required, recommended, or accepted by the manufacturer. Provide chemically and adhesively compatible surface treatment when required or necessary to reduce pH and MVER to within allowable limits required, recommended, or accepted by the manufacturer.
2. Install cement underlayment only after penetrating items are installed.

C. Scheduling:
1. Concrete Substrate Curing: Allow enough time in the construction schedule for concrete to cure for at least 28 days before beginning surface preparation and installation.
2. Primer Installation: Cement underlayment must be applied within 24 hours of primer installation. Re-prime surfaces exposed for more than 24 hours; follow manufacturer's instructions for re-priming.
3. Finishing Flooring Installation: Do not install floor coverings until after the minimum time recommended in writing by the manufacturer has passed.
4. Access Restrictions: Close spaces during installation; keep closed to foot traffic after installation for at least 48 hours and to rolling load traffic for at least 72 hours.

1.4 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data: Submit manufacturer's product data, specifications, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs) and safety data sheets (SDSs),both of which are returned to the Contractor without review or responsive action.

B. Informational Submittals: Submit the following for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
   1. Manufacturer's Instructions: Submit manufacturer-prepared published instructions for proper installation of furnished cement underlayment.
      a. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.
      b. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.
   2. Qualification Statements: Submit written descriptions confirming experience specified in QUALITY ASSURANCE article below.

1.5 QUALITY ASSURANCE

A. Source Limitations:
   1. Cement underlayment must be obtained through one source from the same manufacturer (to ensure compatibility and a warrantable installation).
      a. Certain cement underlayments may be obtained from more than one manufacturer, but only when used for separate installations.
      b. Items provided for each different installation must be obtained from the same source and manufacturer.
   2. Provide secondary materials, components, accessories and other items from sources required, recommended, or accepted by the primary manufacturer for actual in-service conditions applicable to the project.

B. Qualifications:
   1. Installer: Company or individuals must have at least 5 years' experience installing cement underlayment for at least 30 previous projects similar to this project in size, material, design, and complexity.
   2. Supervisors: Individuals must have at least 7 years' experience installing cement underlayment for at least 30 previous projects similar to this project in size, material, design, and complexity, including at least 2 years' supervisory experience directing and leading cement underlayment installers.

1.6 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
   1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
   2. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items as shipped and in conformance with manufacturer's instructions and other requirements and recommendations for storage. Furnish adequate dunnage during storage.
   1. Prevent stored items from contacting the floor or ground and from deterioration and damage.
   2. If items are not stored in an enclosed location, then cover the tops and sides with securely-tied, waterproof, and breathable covers. Unvented polyethylene tarpaulins do not qualify as breathable covers and are prohibited. (due to potential accumulation of moisture beneath tarpaulin during certain environmental conditions)
   3. Incline covered items to ensure maximum drainage of accumulated moisture.
   4. Do not leave items uncovered where they might be exposed to weather or become wet from rain, mist, relative humidity, condensation, frost, and other sources of moisture; or exposed to other sources of deterioration and damage.

C. Handling: Handle items in conformance with manufacturer's instructions and other requirements and recommendations, and in a manner that that prevents damage.
   1. Avoid damage to packaging and containers, and contamination of contents.
   2. Rotate inventory; do not use items the shelf life of which is expired.

D. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective cement underlayment materials with undamaged new cement underlayment materials that do not exhibit deterioration, damage, or defects.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

1.7 PROJECT CONDITIONS

A. Ambient Conditions: Install cement underlayment only when ambient temperature, RH, and other environmental conditions fall within ranges required, recommended, or accepted by the manufacturer.

B. Existing Conditions:
   1. Surface Conditions: Install cement underlayment only when substrate moisture content, vapor emission rate, and surface temperature fall within ranges required, recommended, or accepted by the manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer: Provide products manufactured by one of the following, or equal.
   1. ARDEX Group.
   2. Custom Building Products.
   3. Floor Seal Technology, Inc.
   4. LATICRETE International, Inc.
   5. Mapei Corp.

2.2 HYDRAULIC CEMENT UNDERLAYMENT

A. Description: Portland-cement-based, non-structural, engineered cementitious material specifically designed for use as interior flooring cement underlayment. Products with added gypsum are prohibited.

B. Application: Installed over subfloors to help achieve specified floor flatness values; and to smooth and correct surface irregularities prior to flooring installation.

C. Self-Leveling Products:
   1. Pourable Grade Cement Underlayment Applications (0 to 1-1/4 inches thick): “ARDEX V-1200” self- leveling, no-troweling cement underlayment manufactured by ARDEX Americas, or equal. Primer is required.
   2. High-Flow Cement Underlayment Applications (1/16- to 1/2-inch thick): “ARDEX K 10” reactivatable high-flow, self-leveling cement underlayment manufactured by ARDEX Americas, or equal. Primer is required.
   3. Thicker Cement Underlayment Applications (1/4-inch to 5 inches thick): “ARDEX K 15” self-leveling polymer-modified cement underlayment manufactured by ARDEX Americas, or equal. Primer is required.
      a. For application thickness between 1/4-inch and 1-1/2 inches thick, apply neat.
      b. For application thickness between 1-1/2 and 5 inches thick, apply with aggregate.
   4. Fiber Reinforced Underlayment Applications (1/4-inch to 5 inches thick): “ARDEX K 22 F” high-flow, fiber-reinforced, self-leveling underlayment manufactured by ARDEX Americas, or equal. Primer is required.
      a. For application thickness between 1/4-inch and 1-1/4 inches thick, apply neat.
      b. For application thickness between 1-1/4 and 2 inches thick, apply with aggregate.

D. Trowel Grade Products:
   1. Non-Structural Repair, Re-Slope, and Re-Forming Material: “ARDEX CP” Portland cement-based concrete topping for filling and repairing indoor and outdoor concrete flatwork manufactured by ARDEX Americas, or equal.

2. Structural Repair Mortar: “ARDEX ERM” Polymer modified structural repair mortar with integral corrosion inhibitor manufactured by ARDEX Americas, or equal.

2.3 PATCHING MATERIAL

A. Patching Compound: “ARDEX SD-F Feather Finish” self-drying finishing cement underlayment manufactured by ARDEX Americas, or equal. Primer is typically not required.

2.4 SURFACE PREPARATION

A. Substrate Testing and Surface Preparation: Perform testing and corrective work and prepare substrates in conformance with the requirements of Section 09 05 16.

B. Concrete Surface Profiling: Provide ICRI concrete surface profile CSP 3 to CSP 5 (light to medium shotblast between 10 and 40 mils), unless otherwise explicitly required, recommended, or accepted in writing by the covering manufacturer. Conform to the requirements of Section 09 05 16.

2.5 INSTALLATION MATERIALS

A. Primers:
   1. Standard Absorbent Concrete, Gypsum, and Other Porous Substrates (in Specialized Applications): “ARDEX P 51” manufactured by ARDEX Americas, or equal.
      a. Two applications of primer must be applied over gypsum cement underlayment.
      b. Two applications of primer may be required over absorbent concrete cement underlayment.
   2. Wood, Cutback Residue, Metal, and Other Non-Porous Substrates: “ARDEX P 82 ULTRA PRIME” manufactured by ARDEX Americas, or equal.

B. Additive: “ARDEX E 25” resilient emulsion manufactured by ARDEX Americas, or equal, for use over cutback and other adhesive residues on concrete subfloors only; over metal; and as part of mesh-reinforced wood subfloor systems.

C. Crack Repair Compound: “ARDEX ARDIFIX” 100-percent solids, 2-part polyurethane repair compound manufactured by ARDEX Americas, or equal, for repair of non-moving joints and cracks.

D. Joint Filler: “ARDEX ARDISEAL Rapid Plus” 2-part, self-leveling, semi-rigid polyurea joint filling compound manufactured by ARDEX Americas, or equal, for repair of all moving joints.

E. Sand: Washed masonry or plaster sand, 1/8-inch diameter and smaller.

F. Aggregate: Well-graded washed gravel, 1/8- to 1/4-inch diameter or larger, supplied, required, recommended, or accepted by the manufacturer for proposed thicknesses.

G. Mix Water: Provide fresh, clean, clear, potable water from a domestic source. Water must conform to ASTM C 1602 and be free of oil, grease, waxy films, curing compounds, release agents, and other deleterious materials, including salts, acids, alkalis, organic materials, detergents, and other matter that might negatively affect cement underlayment quality, durability, or performance.

2.6 ACCESSORIES

A. Perimeter Isolation Strips: Supplied, required, recommended, or accepted by the manufacturer.

B. Other Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

2.7 MIXING

A. Site Mixing: Batch mix cement underlayment in conformance with manufacturer's instructions and other requirements and recommendations, using manufacturer-recommended techniques and manufacturer-recommended mechanical mixing equipment, which must be clean and free of material from previously mixed batches before charging each subsequent batch.
   1. Measure mix materials using only graduated mixing containers and calibrated mixing equipment. Shovels do not qualify as graduated mixing containers or calibrated equipment and are prohibited from measuring or dispensing mix materials.
   2. Thoroughly agitate and stir mix materials to a uniform and smooth consistency suitable for proper installation.
   3. Do not reduce, alter, or introduce foreign materials into mix materials, , including primers, additives, compounds, and fillers, except in conformance with manufacturer's instructions and other requirements and recommendations.
   4. Do not use caked or lumpy materials; or materials that are irregular, too thick or too thin, or that are partially set.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification:

1. Verify in-place construction, project conditions, and the work of other specification sections conform to the manufacturer's instructions and other requirements and recommendations.
2. Verify subfloor surfaces are properly secured, smooth, and flat to minimum floor flatness and levelness tolerances required, recommended, or accepted by the manufacturer for the actual in-service conditions applicable to the project.
3. Verify substrates are dry and free of curing compounds, sealers, hardeners, and deleterious and other substances that might interfere with cement underlayment adhesion or performance.
4. Verify items penetrating cement underlayment are installed.

C. Evaluation and Assessment:
1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.
2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 PREPARATION

A. Protection:
1. Adjacent Material Protection: Protect adjacent surfaces against soiling and damage; and from detrimental effects caused by surface profiling operations. Utilize drop cloths, shields, masking, barricades, and other items necessary to protect adjacent surfaces.
2. Opening Protection: Close and protect drains and other openings and penetrations to prevent cement underlayment intrusion or migration.

B. Substrate Preparation: Prepare substrates as required, recommended, or accepted by the manufacturer without limitation; and in a manner that does not result in any warranty or guarantee becoming void.
1. Remove substrate coatings and other substances that are incompatible with cement underlayment or that may negatively affect the quality of installation, durability, or performance.
2. Perform testing and corrective work and prepare substrates in conformance with the requirements of Section 09 05 16. Provide ICRI concrete surface profile CSP 3 to CSP 5 (light to medium shotblast between 10 and 40 mils), unless otherwise explicitly required, recommended, or accepted in writing by the manufacturer.
3. Repair damaged sub-floor and fill cracks.
4. Vacuum-clean substrate.

3.3 INSTALLATION

A. General Requirements:

1. Install cement underlayment using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
2. Remove and replace cement underlayment areas that evidence lack of bond with substrate, including areas that emit a “hollow” sound when tapped.
3. Installed cement underlayment must be warrantable. Do not install, correct, or replace cement underlayment in a manner that is un-warrantable by the manufacturer; or that results in any warranty or guarantee becoming void.

B. Special Techniques:
1. Thickness: Install screeds as required, recommended, or accepted by the manufacturer.
   a. Set screeds with a laser level so the minimum cement underlayment thickness is at least 1/8-inch.
   b. Where cement underlayment covers only a small area, grind, chisel, and undercut floor and deck slabs as necessary to ensure a minimum cement underlayment thickness of at least 1/8-inch.
2. Place cement underlayment in one continuous operation, without cold joints, to produce uniform and level surfaces.
   a. Screed cement underlayment to levels and tolerances required, recommended, or accepted by the finish flooring manufacturer.
   b. Feather edges to match adjacent floor elevations.
3. Cure cement underlayment in conformance with the manufacturer's instructions. Protect cement underlayment to prevent contamination during installation and curing.

3.4 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
1. written descriptions of non-conforming, damaged, and defective work;
2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect’s acceptance.

3.5 CLEANING

A. Cleaning Work: Clean spills, stains, and soiling from adjacent surfaces.
   1. Use cleaning materials, equipment, and accessories supplied, and means, methods, techniques, and procedures required, recommended, or accepted by the manufacturer.
   2. Do not use cleaning materials or procedures known to change, or that might change, the appearance of exposed finishes or adjacent surfaces; or cause deterioration or damage to exposed finishes or adjacent surfaces.
   3. Protect adjacent surfaces not being cleaned from staining, deterioration, damage, or other detrimental effects caused by cleaning.
   4. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be cleaned to the Architect's acceptance.

B. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

END OF SECTION

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SECTION 03 60 00 – GROUT AND DRY-PACK

PART 1 - GENERAL

1.1 REFERENCES

A. General
   1. The publications listed below form a part of this specification to the extent referenced.
   2. Where a date is given for reference standards, the edition of that date shall be used. Where no date is given for reference standards, the latest edition available on the date of Notice Inviting Bids shall be used.

B. ASTM International (ASTM)
   1. ASTM C807, Standard Test Method for Time of Setting of Hydraulic Cement Mortar by Vicat Needle
   2. ASTM C827, Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
   3. ASTM C845, Standard Specification for Expansive Hydraulic Cement
   4. ASTM C1090, Standard Test Method for Measuring Changes in Height of Cylindrical Specimens of Hydraulic-Cement Grout
   5. ASTM C1107, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

C. Society for Protective Coatings (SSPC)
   1. SSPC SP-5, White Metal Blast Cleaning

1.2 SUBMITTALS

A. Product data shall be submitted as follows.
   1. Nonshrink Grout: Material specifications.
   2. Bagged Cement for Dry-Pack Grout: Type and brand of cement.
   3. Polymer-Modified Portland Cement Grout: Material specifications.
   4. Aggregate: Source of fine and coarse aggregate. Once approved, the source of fine or coarse aggregate shall not be changed without written approval of the Engineer.

B. Samples: The following samples shall be submitted.
   1. Three standard bags of nonshrink grout for testing by the testing agency
   2. One sample of component A and 1 sample component B for polymer-modified, Portland cement, nonsag grout for testing by the testing agency
   3. One 30-pound sample of each size of aggregate

C. Test Reports and Certifications: The following reports and certifications shall be submitted.
   1. Nonshrink Grout: The Contractor shall provide laboratory test reports for nonshrink grouts showing actual test data indicating compliance with specifications and including the following information.
      a. ASTM C1107, including all items of paragraph 12 and height change of hardened grout from 28 to 56 days at 50 percent humidity
      b. Grade of grout tested
      c. Maximum working time tested
      d. Temperatures at which the specimens were prepared and temperature and humidity during curing
      e. Setting time in accordance with ASTM C807 for each temperature specimen tested in accordance with ASTM C1107
      f. Early volume change in accordance with ASTM C827, including height/time graph through final set
      g. Linear vertical height change in accordance with ASTM C1090
      h. Certification that nonshrink properties are not due to gas expansion
   2. Cement: Mill test reports and certificates of compliance shall be submitted.
   3. Aggregates: Test results for concrete aggregates from an approved testing laboratory shall be submitted.
   4. Manufacturer's Instructions: Manufacturer's printed instructions for use of nonshrink grout and polymer-modified grout shall be submitted.

D. Batch Plant Equipment and Procedures
   1. Equipment and procedures for mixing dry-pack, nonshrink grout, and polymer-modified grout shall be submitted.

E. Plans and Procedures
   1. Safety procedures and disposal methods associated with acid etching and abrasive blasting shall be submitted.

1.3 DEFINITIONS

A. Dry-Pack — Concrete or mortar mixtures deposited and consolidated by dry-packing.

B. Dry-Packing — Placing of zero-slump, or near-zero-slump, grout by ramming it into a confined space.

PART 2 - PRODUCTS

2.1 GROUTS

A. Nonshrink grout shall be an inorganic, nonmetallic, nonstaining, nonshrinking, premixed grout requiring only the addition of water and shall not require mortar cap or other protection following placement and curing.
   1. Nonshrink grouts shall be in accordance with ASTM C1107 except that the compressive strength shall be not less than 5000 psi in 7 days nor less than 6000 psi in 28 days, unless a higher strength is required on the drawings.
   2. The nonshrink properties shall not be based on gas expansion.
   3. Early-age linear vertical change shall show no negative change when tested in accordance with ASTM C827.
   4. Linear vertical height change of hardened grout shall show no negative change when tested in accordance with ASTM C1090.

B. Dry-pack grout shall be a material mix of 1 part Portland cement to 2 parts sand by volume.
   1. Portland cement for dry-pack grout shall be in accordance with Section 03 30 00.
   2. Aggregate for dry-pack grout shall be in accordance with Section 03 30 00 except the gradation for fine aggregate shall be mortar sand.

C. Polymer-Modified Grout
   1. Polymer-modified grout shall be a prepackaged, liquid, polymer-modified, Portland cement, nonsag grout, with or without aggregate, and shall be capable of being applied by trowel to vertical and overhead surfaces.
   2. Acceptable Products: Sika Corporation, Sikatop 123; or equal.

D. Shrinkage-Compensating Grouts
   1. Cement for shrinkage-compensating grout shall be in accordance with ASTM C845, Type E 1K.
   2. Aggregate for shrinkage-compensating grout shall be in accordance with Section 03 30 00 except the gradation for fine aggregate shall be mortar sand.

E. Curing compound shall be in accordance with Section 03 30 00.

2.2 ABRASIVE BLAST MATERIAL

A. Abrasive blast material shall be dry, clean angular garnet. Shot or a mixture of shot and grit shall not be used as an abrasive medium.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

A. Concrete Surfaces
   1. The concrete surface on which the grout will be placed shall be flat, without pockets or grooves.
   2. The surface shall be roughened by green-cutting, bush-hammering, abrasive blasting or other approved means to an amplitude of approximately 1/8 inch. The roughening shall remove all laitance and unsound material. After roughening, the surface shall be cleaned using oil-free compressed air or water. The roughened and cleaned surface shall be protected from subsequent contamination.
   3. When the surface is roughened by bush-hammering, only small hand tools or a small pneumatic hammer shall be used. Moil-point and chisel-point tools are not permitted. Large jack hammers or paving breakers shall not be used.
   4. The concrete surface shall be continuously saturated with water for at least 24 hours immediately prior to grouting.

B. Concrete Anchor Bolt Holes
   1. Surfaces of holes shall be newly exposed parent concrete, free of loose and unsound materials. Surfaces shall be prepared by mechanical abrasion unless this practice is prohibited by environmental limitations, in which case acid etching may be used.
   2. For mechanical abrasion, the Contractor shall use abrasive-blasting, scarifying, waterblasting, or other approved means.
   3. For acid-etching, a 15-percent solution of phosphoric acid shall be used. Stiff bristle brooms or brushes shall be used to spread the acid evenly over the surface. After the foaming action stops in 3 to 5 minutes, the surface shall be flushed thoroughly with water, then scrubbed with the same stiff brooms or brushes to remove salts formed by the acid reaction with the Portland cement, and to free loose particles. The procedure shall be repeated until laitance is completely removed. Anchor-bolt sleeves, holes, and similar items shall be cleaned of debris, dirt, and water by oil free compressed air or vacuum. Concrete in the holes shall be saturated with water for 24 hours immediately prior to grouting. Free water resulting from the saturation of the concrete shall be completely removed from the hole using oil-free compressed air, vacuum devices, or absorbent materials. Where absorbent materials are used, they shall be completely removed, and no residue or pieces of the material shall remain.
   4. Anchor-bolt sleeves and holes shall be grouted before placing grout under materials, articles, or equipment.

C. Carbon Steel Surfaces
   1. Carbon steel surfaces shall be blast-cleaned in accordance with SSPC SP-5. Sand shall not be used as an abrasive.
   2. Blast-cleaning residue shall be removed with compressed air from an oil-and-water-free compressed air source.

3.2 FORMWORK

A. General
   1. Forms shall be designed to resist loads resulting from the type and consistency of the grout, method of placement, and the distance the grout must travel. The forms shall be built so that the grout can be placed continuously.
   2. Forms shall be rigid, tight-fitting, and sealed to prevent leakage. Forms shall extend a minimum of 1 inch above the highest grout elevation under the material, article, or equipment to be grouted. Forms shall also be provided to prevent grout from flowing over the top surface of the material, article, or equipment.
   3. Forms shall be coated with a release agent or lined with polyethylene. Contamination by the release agent of the concrete surface or the underside of the material, article, or equipment being grouted will not be permitted. Corners shall be chamfered.
   4. Forms shall be constructed or alternative protection shall be provided to prevent grout from contaminating the material, article, or equipment being grouted.

B. Forms for Placement of Fluid or Flowable Grouts
   1. Where grout will be placed from one side of the material, article, or equipment and allowed to flow to the other side, the forms shall be constructed to provide a head of grout on the placing side. The forms shall provide sufficient clearance to permit strapping, rodding, or vibrating to achieve full contact of the grout with all surfaces being grouted.
   2. Forms on the placement side shall extend above the bottom of the material, article, or equipment to be grouted to form a headbox. The headbox shall be offset horizontally 2 to 4 inches and shall slope away at an angle of 45 degrees. The form on the opposite side shall offset horizontally 2 to 4 inches and shall extend at least 1 inch above the bottom of the material, article, or equipment to be grouted. The height of the headbox above the highest grout elevation shall be a minimum of 1/5 of the travel distance for the grout.
   3. Forms parallel to the direction of grout flow shall be less than 1 inch from the material, article, or equipment to be grouted.
   4. Where the grout will be pumped under the material, article, or equipment through grout holes, the forms shall be at least 4 inches outside on all sides and shall extend at least 1 inch above the highest grout elevation.

C. Forms for Dry-Packing
   1. Forms for dry-pack shall be rigid and well-braced to prevent movement during compaction. Movement of forms during compaction will be cause for rejection of the dry-pack.
   2. Forms shall have openings sufficient for access to all parts of the material, article, or equipment to be dry-packed.

3.3 PROPERTIES AND MIXING

A. Consistency and Mixing
   1. Water content shall be determined by the consistency necessary for placement. Water content of the grout shall not exceed the maximum or minimum stipulated by the manufacturer's printed instructions. Consistency of the grout shall be the minimum that will reliably result in complete filling of the joint space to be grouted.
   2. The water content shall be adjusted to prevent the dry-pack from sloughing or becoming rubbery or crumbly.
   3. Mixing shall produce a grout of uniform consistency and free of lumps and unmixed material. Placing shall commence at the completion of mixing. No water shall be added after mixing is completed. Grout to be poured shall be mixed to produce a pourable consistency without segregation of the constituents.
   4. Plastic, flowable, and fluid grouts shall be mechanically mixed using horizontal shaft mortar mixers with stationary drums. Vertical shaft mixers may also be used if they are clean and equipped with rubber-tipped blades. Mixers shall provide adequate shearing action in the fresh grout to break up all lumps and adequately disperse the constituents. Hand mixing and portable revolving drum concrete mixers are not permitted.
   5. Small quantities of plastic, flowable, or fluid grouts may be mixed using an impeller-type mixer and drill motor provided the drill speed is slow enough to prevent working air into the grout. Where less than full bags of constituent materials are used, ingredients shall be represented properly in the portion taken.
   6. Dry-pack grout shall be mechanically mixed in a horizontal shaft mortar mixer. Small quantities may be hand mixed. Material that has a lack of consistency, dry or unwetted material, or lumps shall not be used.
   7. When grouting base plates and the underside of existing concrete or masonry, rest the mixed grout for up to a minute as recommended by the grout manufacturer as necessary to permit excessive entrained air to escape prior to placing.

B. Temperature
   1. Temperature of the grout shall be adjusted to be within the ranges specified in the manufacturer's printed instructions.
   2. The as-mixed temperatures of the grout may be reduced by using cold water, ice, or precooling of the dry materials. Under cold conditions, the initial as-mixed temperature may be increased by using warm water during mixing or by storing the ingredients in a warm area.
   3. The temperature of the material, article, or equipment to be grouted shall be within the placing range specified by the manufacturer for the grout. Temperatures of the foundation surface and of the material, article, or equipment may be reduced to within the permissible placing range for the grout by cooling with ice or cold water. Under cold conditions, temperatures of the foundation surface and of the material, article, or equipment may be increased by using heating blankets or heated enclosures.

3.4 PLACING

A. Poured Placements
   1. Grout shall be placed continuously without interruption to completion. Grout shall be poured from one side only and shall be contained in a manner that will ensure filling of voids. Placement shall begin at one end of the material, article, or equipment and continue at that point until the grout rises above the bottom of the material, article, or equipment on the opposite side.
   2. The placement point or portable headbox shall be moved slowly along the side of the material, article, or equipment from beginning to end. The placement point shall be moved at the same rate as the face of grout moves along the length of the material, article, or equipment on the opposite side.
   3. Steel strapping may be inserted on the placement side and moved slowly back and forth to facilitate the flow of grout. Chains shall not be used. The use of vibrators or plungers to assist grout flow shall be subject to the approval of the Engineer.
   4. Materials, articles, or equipment with stiffeners or other obstructions on the grout side shall be vented. Vents shall be placed or positioned to prevent the entrapment of air. The location and construction of vents shall be subject to the approval of the Engineer.

B. Pumped Placement
   1. Pumping shall begin at the grout inlet nearest one end of the material, article, or equipment. Grout shall be pumped into that inlet until grout flows up into an adjacent inlet and flows from the entire perimeter of the material, article, or equipment adjacent to the inlet. The pump line shall then be moved to the adjacent inlet, and pumping shall continue. The pump line shall be moved to successive inlets until grouting is complete. Grout shall not be pumped into more than one inlet simultaneously or before grout flow has reached an adjacent inlet.
   2. When a hose is used to place grout under material, articles, or equipment, it shall be inserted from one side to the point furthest from the point of insertion. The hose shall be withdrawn as grout is pumped. The hose outlet shall remain embedded in the grout mass.

C. Dry-Pack Placement
   1. Dry-Packing Base Plates and Equipment
      a. Dry-pack placement and compaction shall be against solid formed backing of sufficient strength to absorb the force of dry-pack compaction without deflection or other deformation.
      b. The exposed concrete surface to receive dry-pack shall be presoaked prior to placing the dry-pack.
      c. The dry-pack grout shall be placed in layers, each having a compacted thickness of approximately 1/2 inch. Each layer of grout shall be compacted over its entire surface with the square-cut end of a board driven with a hammer. The striking force shall be sufficient for compaction of the dry-pack without moving the material, article, or equipment out of alignment. The direction of tamping shall be varied so that compaction of all dry-pack is accomplished

d. The surface of each layer shall be inspected visually or by probing with a rod prior to placement of the next layer to ensure that the entire surface has been compacted.
e. Immediately prior to placement of the next layer, the compacted dry-pack layer shall be rubbed with the end of the tamping rod to provide a slight roughness.
f. The final layer shall be finished immediately after compaction by laying the flat side of a board against the fill and striking the board firmly with a hammer.
g. Dry-pack surfaces shall be cured as specified in this section.

2. Concrete Patching by Dry-Pack Methods
a. Core holes, holes left by the removal of form ties, cone-bolt and she-bolt holes, narrow slots cut for repair of cracks, and areas that are small in width and relatively deep shall be repaired using dry-pack concrete. Dry-pack shall not be used for shallow depressions where lateral restraint cannot be obtained nor for filling behind steel reinforcement.
b. Holes for dry-pack shall have a minimum depth of 1 inch and shall be square at the surface edge. A careful inspection shall be made to ensure that the hole is thoroughly clean and is in sound concrete.
c. Holes left by the removal of tie rods or fasteners from the ends of the tie rods shall be properly reamed with suitable toothed reamers before being filled with dry-pack mortar.
d. The interior surfaces of the hole shall be presoaked prior to application of the mortar bond coat or dry-pack.
e. A mortar bond coat consisting of 1 part Portland cement to 1 part sand mixed with water to give a fluid paste consistency shall be thoroughly brushed onto the hole surfaces prior to placing dry-pack. Bond coat shall not be allowed to dry prior to placement of dry-pack.
f. The dry-pack mortar shall be immediately packed into place in approximately 1/2-inch compacted layers before the bond coat has dried. Each layer shall be compacted over its entire surface with the square-cut end of a board driven with a hammer.

3.5 FINISHING

A. Surfaces shall be finished to match surrounding concrete. Proportions of the grout or dry-pack mix shall be modified by the addition of white cement to provide a color match to the adjacent concrete.

3.6 FORM REMOVAL

A. Removal of the forms or grout, except spillage, from formed shoulders shall not be done until the grout has stiffened sufficiently to ensure the grout will not sag.

B. After removal of forms, the placed grout shall be tapered away from the base of the material, article, or equipment at a slope of 45 degrees with the horizontal.

3.7 CURING

A. The exposed surfaces of newly placed grout or dry-pack shall be protected from drying by using wet burlap, wet sand, plastic sheeting, or a water soaker hose and shall be kept continuously moist for 7 days. After 7 days and while the surface is still damp, 2 coats of curing compound shall be applied to prevent moisture loss.

B. After placement of grout, the foundation and the material, article, or equipment shall be kept at a temperature that is within the temperature range specified for placing of the fresh grout until the grout has attained final set. The grout shall be protected from cold or hot temperatures until the specified strength is attained.

C. During cold weather, grout or dry-pack shall be maintained above 50° F.

D. During hot weather, the grout or dry-pack temperature shall be controlled for a minimum of 3 days through the use of shade, wet burlap, soaker hoses, or other approved procedures.

3.8 FIELD QUALITY CONTROL

A. Both fresh and hardened grout will be subject to sampling and testing by the Engineer.

3.9 CLEANING

A. Excess grout, laitance, and spatter shall be cleaned from adjacent surfaces.

END OF SECTION

DIVISION 05

METALS

SECTION 05 12 00 – STRUCTURAL STEEL

PART 1 - GENERAL

1.1 REFERENCES

A. General
   1. The publications listed below form a part of this specification to the extent referenced.
   2. Where a date is given for reference standards, the edition of that date shall be used. Where no date is given for reference standards, the latest edition available on the date of Notice Inviting Bids shall be used.
   3. In the event of conflict between referenced standards, AISC shall govern over AWS and ASTM, and AWS shall govern over ASTM.

B. American Institute of Steel Construction (AISC)
   1. ANSI/AISC 360, Specification for Structural Steel Buildings
   2. AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts, approved by the Research Council on Structural Connections of the Engineering Foundation (RCSC Specification)
   3. AISC Steel Construction Manual

C. American Society of Mechanical Engineers (ASME)
   1. ANSI/ASME B46.1, Surface Texture (Surface Roughness, Waviness, and Lay)

D. American Society for Non-Destructive Testing
   1. ASNT, SNT-TC-1A, Recommended Practice

E. ASTM International (ASTM)
   1. ASTM A6, Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
   2. ASTM A29, Standard Specification for Steel Bars, Carbon and Alloy, Hot-Wrought, General Requirements for
   3. ASTM A36, Standard Specification for Carbon Structural Steel
   4. ASTM A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
   5. ASTM A108, Standard Specification for Steel Bars, Carbon and Alloy, Cold-Finished
   6. ASTM A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
   7. ASTM A153, Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware

8. ASTM A307, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod, 60,000 psi Tensile Strength
9. ASTM A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
10. ASTM A500, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
11. ASTM A563, Standard Specification for Carbon and Alloy Steel Nuts
12. ASTM A572, Standard Specification for High-Strength, Low-Alloy Columbium-Vanadium Structural Steel
13. ASTM A673, Standard Specification for Sampling Procedures for Impact Testing of Structural Steel
14. ASTM A992, Standard Specification for Structural Steel Shapes
15. ASTM B633, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
16. ASTM F436, Standard Specification for Hardened Steel Washers
17. ASTM F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

F. American Welding Society (AWS)
1. AWS A2.4, Standard Symbols for Welding, Brazing and Nondestructive Examination
2. AWS A5.1, Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
3. AWS A5.5, Specification for Low Alloy Steel Electrodes for Shielded Metal Arc Welding
4. AWS A5.17, Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding
5. AWS A5.18, Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding
6. AWS A5.20, Specification for Carbon Steel Electrodes for Flux Cored Arc Welding
7. AWS A5.23, Specification for Low Alloy Steel Electrodes and Fluxes for Submerged Arc Welding
8. AWS A5.28, Specification for Low Alloy Steel Electrodes and Rods for Gas Shielded Arc Welding
9. AWS A5.29, Specification for Low Alloy Steel Electrode for Flux Cored Arc Welding
10. AWS D1.1, Structural Welding Code—Steel

G. International Code Conference (ICC)
1. California Building Code (CBC)
2. Evaluation Service Reports (ESR)

H. Society for Protective Coatings (SSPC)
1. SSPC SP 3, Power Tool Cleaning
2. SSPC SP-6, Commercial Blast Cleaning

1.2 SUBMITTALS

A. Shop Drawings
   1. Before beginning fabrication of structural steel, the Contractor shall submit complete shop (fabrication and erection) drawings showing details of methods, materials, complete details of all connections, including tolerances, and finishes. Drawings shall clearly distinguish between shop or field welds and bolts.
   2. Separate plans for the setting of anchors and bearing plates, prepared in coordination with concrete placement drawings, shall be submitted and approved prior to the placement of concrete containing anchors or bearing plates.
   3. Erection drawings shall indicate sequences of erection, bracing procedures, and schedule for welding, bolt tensioning, and testing.
   4. Shop drawings shall include details of Contractor's material identification, erection mark, and member piece mark procedures.
   5. Where applicable, the procedure to be used to tension slip-critical connections with high-strength bolts shall be submitted.
   6. Welding symbols shall be in accordance with AWS A2.4.

B. Mill test reports in accordance with ASTM A6 for all structural steel

C. Weld material Manufacturer certifications demonstrating compliance with AWS A5.

D. Material Samples: The Contractor shall field submit 3 assemblies for each size of bolt, nut, and washer for testing.

E. Weld Procedures and Qualifications
   1. Prequalified welding procedures will not be permitted.
   2. Welding Procedure Specifications (WPS) shall be submitted for approval for proposed welding procedures in accordance with AWS D1.1.
   3. A Welding Procedure Qualification Record (PQR) shall be submitted for approval to support proposed welding procedures.
   4. Welder, Welding Operator, and/or Tack Welder Qualification Test Records shall be submitted for approval for all welding personnel proposed for employment on the project in accordance with AWS D1.1.
   5. Required WPS, PQR, WPQ shall be submitted and approved prior to performing any welding. Failure to submit required WPS, PQR, and WPQ is sufficient cause for rejection of all weldments.
   6. When required by the Engineer, welders shall be tested to demonstrate their ability to produce welds that are in compliance with these specifications. Tests shall be in accordance with AWS D1.1 and shall be made using the machines, electrodes, and positions to be used in the work. Tests shall be performed in the presence of the Engineer.
   7. The Engineer may require additional test plates as the work progresses and may demand the removal from the project of any welder whose work is not satisfactory, regardless of the quality of the test welds.

F. Quality Control Submittals: The Contractor shall submit the following items:
   1. Certified mill test reports or certified reports of tests made by an approved testing laboratory for all materials and fastener assemblies.
   2. Non-destructive testing (NDT) procedures and testing personnel qualifications for shop and field testing. Testing personnel shall be certified to ASNT SNT-TC-1A, Level II minimum.
   3. The Contractor shall submit the fabricator's quality control plan to the Engineer for review and approval prior to starting fabrication.
   4. Non-destructive Testing Reports shall be submitted for shop and field welding.

1.3 QUALITY ASSURANCE

A. Records of steel manufacture shall be kept, materials shall be properly identified, and shop fabrication records shall show that the proper material was incorporated into each item. Such records shall be available to the Engineer upon request.

B. The Contractor shall be responsible for the review and implementation of the approved Quality Control Plan.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Bolts shall be shipped in separate containers according to length, diameter, and ASTM designation. Nuts, washers, pins, and other small parts shall be shipped in separate containers according to size and ASTM designation. Descriptions and quantities of the material shall appear on the outside of each container.

B. During erection operations, the Contractor shall handle and store materials to avoid accumulation of dirt and foreign matter. The Contractor shall remove dust, dirt, or other foreign matter prior to erection.

C. Structural members loaded for shipment to the jobsite shall be loaded and supported so that they can be transported and unloaded without being stressed, deformed, or otherwise damaged.

D. Structural steel and packaged materials shall be stored and protected from corrosion and deterioration. Materials, including fastener containers, shall be stored in a dry area and shall not be placed in direct contact with the ground. Structural members shall be supported at sufficient intervals during storage so as to not cause overstress, permanent deformation, or other damage.

E. Primed structural steel showing evidence of oxidation or failure shall have the prime coat removed and the steel prepared and re-primed in accordance with the Architectural Drawings.

PART 2 - PRODUCTS

2.1 STRUCTURAL STEEL

A. Except as otherwise specified on the drawings, materials for structural steel and appurtenances shall be as follows:
   1. Rolled plates, shapes, bars, and shims shall be in accordance with ASTM A36.
   2. Hot-rolled W shapes shall be in accordance with ASTM A992, GR50.
   3. Structural steel pipe shall be in accordance with ASTM A53 Type E or Type S, Grade B.
   4. Structural tubing shall be in accordance with ASTM A500, Grade B.
   5. Unidentified steel shall not be used.
   6. High-strength steel, where indicated on the drawings, shall be in accordance with ASTM A572, Grade 50.

B. Galvanizing shall be in accordance with ASTM A123, ASTM A153, and Section 05 50 00.

2.2 FASTENERS

A. General
   1. Bolt length shall be increased as required when washers are used.
   2. All holes shall be standard holes unless otherwise noted on the drawings. Provide oversized holes where specifically permitted at column base plates or in the case of threaded end-welded studs to account for the weld flash region.
   3. Bolts used in holes 1/8 inch or more oversized shall be provided with washers conforming to ASTM F-436 at each contact surface unless otherwise shown on the drawings.
   4. Bolts or studs used in tapped holes shall be of sufficient length to provide an engagement length at least equal to the nominal diameter of the bolt or stud or the thickness of the tapped member, whichever is less.

B. Where shown on the drawings, galvanizing shall be in accordance with ASTM A153 and Section 05 50 00. Bolts, Nuts, and Washers for Structural Connections
   1. Bolts for structural connections shall be high-strength, heavy hex head, in accordance with ASTM A325, Type 3 unless otherwise shown on the drawings. High-strength bolts shall be bearing-type (A325N) unless otherwise shown on the drawings. Where welding is required, material shall comply with ASTM A307 Supplement S-1.
   2. Nuts for high-strength bolted connections shall be in accordance with ASTM A563, Grade C3 or DH3 heavy hex.
   3. Hardened washers shall be in accordance with ASTM F436, Type 3.
   4. Threads for bolts 1-1/8 inches and greater in diameter shall be 8-pitch thread series.

5. Hardened steel washers shall be provided at all locations required by the RCSC Specification. The type of washer shall match the bolt type and finish. Bolt length shall be increased when hardened washers are used.
6. Thread projection beyond nut shall be no less than 3 threads except where specifically permitted on the Drawings.
7. Provide heavy-duty oversized washers where specifically indicated, and for steel to steel connections using end-welded threaded studs requiring larger diameter holes to accommodate the weld-flash dimension.
8. Finish shall match the exposed finish of the bolt installed, unless otherwise noted.

C. Anchor Bolts, Machine Bolts, and Threaded Rods
1. Anchor bolts, machine bolts, and threaded rods shall be heavy hex and in accordance with ASTM A307, Grade A, with Supplement S-1 where welding is required, unless otherwise shown.
2. Threaded rod, ASTM A36 unless noted otherwise. ASTM A307 Grade A where specified on the Drawings.
3. Anchor bolts: ASTM F1554 Grade 36. Use of J-bolts is prohibited unless specifically indicated on the Drawings.
4. Nuts and threaded couplers shall be in accordance with ASTM A563, Grade A, heavy hex. Same finish as the attached anchor.
5. Hardened washers shall be in accordance with ASTM F436, Type 3.

2.3 WELD FILLER METALS

A. All weld filler materials shall be capable of producing welds that meet a Charpy V-notch impact test value of 20 foot pounds at 0° F in accordance with ASTM A673 unless otherwise noted.
1. For shielded metal arc welding (SMAW), electrodes shall be in accordance with AWS A5.1 or AWS A5.5 Type E 70XX, low hydrogen or Type E-70XX-X, low hydrogen.
2. For submerged arc welding (SAW), electrodes and flux shall be in accordance with AWS A5.17 or AWS A5.23 Type F7A2 EM12K.
3. For gas-shielded metal arc welding (GMAW) electrodes shall be in accordance with AWS A5.18 or AWS A5.28 Type ER70S-2 or ER70S-6.
4. Flux-cored arc welding (FCAW) electrodes and flux shall be in accordance with AWS A5.20 or AWS A5.29, with auxiliary gas shielding and a minimum tensile strength of 70 ksi. E70T-4 electrodes shall not be used.

2.4 WELDED STUD ANCHORS

A. Welded stud anchors shall be in accordance with AWS D1.1 Section 7 and ASTM A108 and A29, Type B, Grade 1010 through 1020 cold drawn steel or low carbon mild steel, unless otherwise noted on the drawings.

B. Welded stud anchors to be embedded in concrete and shown to be attached to the structural steel shall be standard steel stud units intended for automatic stud welding process, furnished complete with an arc shield (ferule) of heat-resistant ceramic or equivalent.

C. Threaded end-welded studs: refer to Section 05 50 00.

D. Finish: welded studs fully encased on concrete shall not be finished or zinc coated unless specifically indicated. Threaded studs and other fusion-welded anchors not encased on concrete shall be zinc plated steel in accordance with ASTM B-633. Withhold galvanization in the weld region.

E. Acceptable manufacturers: Nelson Stud Welding, or Equal.

2.5 FABRICATION

A. General
   1. The Contractor shall verify existing conditions, dimensions, and field measurements as necessary, and shall be responsible for accurate layout of the work prior to starting of fabrication.
   2. The Contractor shall review the contract drawings, approved shop drawings, erection drawings, and submit discrepancies to the Engineer for review and approval, before starting fabrication.

B. The Contractor shall submit, for approval by the Engineer, a system for identification and verification of structural material, prior to the start of fabrication.
   1. Identification of carbon steel material shall be performed at the mill, prior to delivery, and conform to ASTM A6.
   2. The identification system shall include the ASTM designation, heat number, and material test reports for traceability.
   3. Erection marks shall be applied to the structural steel members by painting or other suitable means, as specified, and as approved by the Engineer.

C. Base Plate Detailing Requirements for Grout/Dry-Pack
   1. Grouted base plates shall be detailed so that grout can be placed beneath the plate without trapping water or air.
      a. Air vent holes 1/4 to 1/2 inch in diameter shall be placed through the plate at the intersection of shear keys or crossing stiffeners, and at all points where air may be trapped.
      b. Holes for placement of the grout shall be located so grout does not travel more than 48 inches. Grout holes shall be located so grouting can be started at one hole and continued to insure that the grout flows under all areas of the plate, such that the plate is fully bearing.
      c. Holes for pumping grout shall be threaded for 3/4- to 2-inch diameter standard pipe.

d. Placement and diameter of grout and vent holes shall be submitted to the Engineer for approval.
e. Unless otherwise shown on the drawings, the following grout thickness shall apply:
   1) Total clearance shall not be less than 1 inch.
   2) For flowable grout placed by gravity, the minimum grout thickness shall be 1 inch per 1 foot flow length, or less.
   3) For each additional foot of flow length, the thickness shall be increased by 1/2 inch, up to a maximum of 4 inches
   4) For grouts with a plastic consistency placed by gravity, the clearances shall be increased by 1 inch above that designated for flowable grouts.
   5) For fluid grouts, the total clearance may be reduced by not more than 1/2 inch.
f. For placements made by pumping through connections in the plate, the clearances shall be governed by flowable grout placed by gravity.

2. For installations to be dry-packed, the clearances shall be as shown on the drawings. If not shown on the drawings, clearance shall be 1-1/2 inches. The area to be dry-packed shall not exceed 18 inches in any direction.

D. General Cutting and Preparation of Material
1. Members shall be furnished full length without splices, unless otherwise shown on the drawings or approved by the Engineer.
2. Abutting members of the same cross section shall be matched to form smooth, contiguous surfaces across the joint.
3. Planing or finishing of sheared or thermally cut edges of plates or shapes shall be performed on surfaces to receive paint or other coatings. Corners that are to be painted and then exposed to weather or corrosive conditions shall be ground to a 1/8-inch-radius curve.
4. Except as otherwise noted in this section, surfaces to be joined by welding shall be finished in accordance with AWS D1.1.
5. Re-entrant corners of coped beams shall be pre-drilled (not punched) to form the radius portion of the cope. Flame-cut section and pre-drilled portions of the cope shall be ground smooth.

2.6 FABRICATION – WELDING

A. The welding of structural steel shall be in accordance with the AISC Specification and with AWS D1.1 unless otherwise specified.
1. Welds shall be continuous unless otherwise shown or specified.
2. Electrodes for SMAW shall not be larger than 1/4 inch for shop welding and not larger than 3/16 inch for field welding.
3. Electrodes and flux shall be maintained in accordance with AWS D1.1 and shall be stored in accordance with the manufacturer's instructions.

4. Low-hydrogen electrodes and heat-treatable electrodes shall be purchased and stored in accordance with AWS D1.1.
5. Drying and holding ovens shall have calibrated temperature controls.
6. Electrodes exposed to water, grease, or dirt shall not be used.
7. There shall be no mixing of dissimilar electrode types. Proper control of the issue of electrode stock shall be maintained at all times.
8. Used flux from automatic welding machines shall be recycled in accordance with AWS D1.1.
9. Rusted or otherwise damaged electrodes shall not be used, and violation of this provision shall be sufficient cause for rejection of the work.
10. Prior to welding, surfaces of members to be welded shall be cleaned of scale and rust by grinding or abrasive blasting for a distance from the weld edge of not less than 1 inch.
    a. Prior to blasting, grease or oil shall be removed with a solvent-based degreaser for a distance of 3 inches from the edge of the weld. Gasoline, kerosene, or other heavier petroleum solvent shall not be used.
    b. For double-groove welded joints, both sides of the plates shall be cleaned.
    c. Blasting shall be performed with dry compressed air and compressed air blast nozzles. Only steel grit or garnet abrasive shall be used. Surfaces shall be blasted in accordance with SSPC SP-6.
    d. Surfaces prepared by grinding shall be in accordance with SSPC SP-3
11. Minimum preheat and interpass temperatures shall be in accordance with AWS D1.1.
12. No welding shall be performed when the temperature of the base metal is below 50° F.
13. Post-weld heat treatment requirements shall be in accordance with AWS D1.1.
14. For multi-pass welds, each pass shall be visually inspected for defects before the next pass.
    a. Defects shall be removed and repaired before the next pass.
    b. The depth of each pass shall not exceed 1/8 inch for manual welding, and the weld puddle width shall not exceed three times the electrode diameter.
15. Tack welds shall be removed unless otherwise specified. Inclusion of tack welds in the finished weld shall require prior approval of the Engineer.
16. The Contractor shall remove runoff tabs, backup bars, and temporary attachments by air-arc gouging, hand flame-cutting or grinding. No hammering will be allowed. The area of temporary attachments will be inspected to verify there are no base metal tears. The area shall be ground to a smooth surface substantially flush to the adjacent material. The base metal shall be restored to its original shape and required dimension. Additional weld reinforcement shall be as shown on the drawings.
17. Welding of pipe, tubes, and other hollow structural elements shall be in accordance with AWS D1.1.
18. Vertical welding shall be performed in uphill progression.

B. Weld Process Restrictions

1. SMAW will be permitted for manual welding.
2. In automatic welding, both the rate of travel and the rate of deposition of metal shall be controlled automatically.
3. SAW will be permitted for automatic or semi-automatic welding.
4. GMAW will be permitted for automatic or semi-automatic welding. Only the spray-arc, non-short-circuiting mode shall be used.
5. FCAW will be permitted for semiautomatic welding provided that auxiliary gas shielding is used.
6. Other welding processes not mentioned shall not be used without prior approval of the Engineer.

2.7 SHOP-APPLIED FINISHES

A. Unless otherwise specified or shown on the drawings, all carbon steel shall be coated as follows:
   1. Galvanized surfaces shall be coated in accordance with Section 05 50 00. Galvanizing of structural steel items shall be done after all fabrication has been completed.
   2. Surfaces of base plates and bearing plates and areas inaccessible for field painting shall be prepared and coated with 3-coats of zinc-rich epoxy primer, shop applied, in accordance with the Architectural Drawings. Partially embedded items shall have the coating system extended 3 inches minimum onto the embedded portion from the exposed portion.
   3. Interior structural steel covered by architectural finishes and not subject to view or specified to receive enamel painting shall be prepared and coated with 2-coats of zinc-rich epoxy primer, shop applied.
   4. All other surfaces shall be prepared and coated with painting system in accordance with the Architectural Drawings. For this coating system, the Contractor may apply the first coat in the shop and the final 2 coats in the field.

B. Surfaces to be coated with fireproofing shall not be primed unless otherwise required by the fireproofing manufacturer's written recommendation.

2.8 FABRICATION TOLERANCES

A. Unless otherwise shown or specified, dimensional tolerances shall be in accordance with the following:
   1. Permissible tolerances for out-of-square or out-of-parallel depth, width, and symmetry of rolled shapes shall be as specified in ASTM A6. The as-fabricated straightness tolerances of members shall be one-half of the standard camber and sweep tolerances in ASTM A6.
   2. The tolerances on overall profile dimensions of members made up from a series of plates, bars, and shapes by welding shall be limited to the accumulation of permissible tolerances of the component parts as provided by ASTM A6. The as-

fabricated straightness tolerances for the member as a whole shall be one-half the standard camber and sweep tolerances for rolled shapes in ASTM A6.

3. Variations in weld profiles and dimensions shall not exceed those permitted by AWS D1.1.
4. All copes, miters, and butt cuts in surfaces exposed to view are made with uniform gaps of 1/8 inch if shown to be open joints, or in contact if shown without gap.
5. Butt and plug welds shall not project more than 1/16 inch above the exposed surface. Unless otherwise stated on the drawings, no finishing or grinding is required except where clearances or fit of other components make it necessary to do so.

B. Surfaces noted as finished on the drawings shall have a maximum roughness height value of 500 in accordance with ANSI B46.1. Techniques such as friction sawing, cold sawing, milling, or other that produces such a finish may be used.

C. A variation of 1/32 inch is permissible in the overall length of members with both ends finished for contact bearing.

D. Members without ends finished for contact bearing, which are to be framed to other steel parts of the structure, may have a variation from the detailed length not greater than 1/16 inch for members 30 feet or less in length, and not greater than 1/8 inch for members over 30 feet in length.

E. Unless otherwise specified, structural members, whether a single-rolled shape or built up, may vary from straightness within the tolerances allowed for wide-flange shapes by ASTM A6, except that the tolerance on deviation from straightness of compression members is 1/1000 of the axial length between points that are to be laterally supported.

F. Beams and trusses detailed without specified camber are fabricated so that after erection any camber due to rolling or shop fabrication is upward.

G. When members are specified on the drawings as requiring camber, the shop fabrication tolerance shall be minus zero / plus 1/2 inch for members 50 feet and less in length, or minus zero / plus (1/2 + 1/8 inch for each 10 feet or fraction thereof in excess of 50 feet in length) for members over 50 feet. Members received from the rolling mill with 70 percent of the specified camber require no further cambering. Camber shall be measured in the fabricator's shop in the unstressed condition.

2.9 FABRICATION QUALITY CONTROL

A. For shop and fabrication quality control requirements, refer to Shop and Field Quality Control Article herein below.

PART 3 - EXECUTION

3.1 PREPARATION

A. General
   1. Unless otherwise specified, the Contractor shall control the method and sequence of erection.
   2. Materials shall not be erected in a sequence nor placed on a structure in a manner that might cause distortion or damage to the members or the supporting structures.
   3. The Contractor shall verify existing conditions for dimensional accuracy prior to starting erection and report any discrepancies to the Engineer.

B. Anchor Bolts and Embedded Items
   1. The tolerances of subparagraphs b, c, and d below apply to offset dimensions shown on the plans, measured parallel and perpendicular to the nearest established column line for individual columns shown on the plans to be offset from established column lines. Anchor bolts and foundation bolts shall be set in accordance with approved submittals. They shall not vary from the dimensions shown on the erection drawings by more than the following:
      a. 1/8 inch center to center of any two bolts within an anchor bolt group, where an anchor bolt group is defined as the set of anchor bolts that receive a single fabricated steel shipping piece.
      b. 1/4 inch center to center of adjacent anchor bolt groups.
      c. Elevation at the top of anchor bolts ± 1/2 inch.
      d. Maximum accumulation of 1/4 inch per hundred feet along the established column line of multiple anchor bolt groups, but not to exceed a total of 1 inch, where the established column line is the actual field line most representative of the centers of the as-built anchor bolt groups along a line of columns.
      e. 1/4 inch from the center of any anchor bolt group to the established column line through that group.
   2. Unless shown otherwise, anchor bolts shall be set perpendicular to the theoretical bearing surface.
   3. Other embedded items or connection materials between the structural steel shall be located and set in accordance with approved location or erection drawings.
   4. Templates shall be furnished for locating and setting anchor bolts.

C. Bearing devices supporting structural steel shall be set and wedged, shimmed, or adjusted with leveling screws to established lines and grades. Bearing devices, wedges, shims, or leveling screws shall be clearly scribed with working lines to facilitate proper alignment. No grouting shall be performed until the Engineer has approved the lines and grades. Tolerance on elevation relative to established grades of bearing devices shall be ± 1/8 inch.

3.2 ERECTION

A. General: Unless otherwise shown or specified, erection of structural steel shall be in accordance with the AISC Specification except that references to the Code of Standard Practice shall not apply.

B. Base Plates
   1. Before erecting structural steel, concrete or masonry bearing surfaces shall be cleaned of bond-reducing materials and shall be roughened.
   2. The bottom of steel base plates shall be cleaned immediately before setting.
   3. The bearing area under the base plates shall be dry-packed solid or grouted after completion of welding on the base plates. Grouting and dry-packing shall be in accordance with Section 03 60 00.
   4. Set the base plate level and true to correct elevations using leveling nuts and washers supplemented with temporary steel shims until supported member has been plumbed and grouted.

C. Structural Framing
   1. Structural framing shall be set accurately to the lines and elevations shown on the drawings and developed by the erection drawings. The steel framing shall be true and plumb within the tolerances specified below.
   2. Frame Tolerances: Acceptable limits do not exceed the cumulative effect of rolling tolerances, fabricating tolerances, and erection tolerances.
   3. Working Points and Working Lines: Erection tolerances are defined relative to member working points and working lines as follows.
      a. For members other than horizontal members, the member work point is the actual center of the member at each end of the shipping piece.
      b. For horizontal members, the working point is the actual center line of the top flange or top surface at each end.
      c. Other working points may be substituted for ease of reference provided they are based upon these definitions.
      d. The member working line is a straight line connecting the member working points.
   4. Position and Alignment: The tolerances on position and alignment of member working points and working lines are as follows.
   5. Columns: Individual columns are considered plumb if the deviation of the working line from a plumb line does not exceed 1:500, subject to the following limitations.
      a. The member working points of columns adjacent to elevator shafts may be displaced no more than 1 inch from the established column line.
      b. The member working points of exterior columns may be displaced from the established column line no more than 1 inch toward nor 2 inches away from the building line.
      c. The member working points of exterior columns at any splice level for multi-tier structures and at the tops of columns for single-tier structures may not fall outside a horizontal envelope, parallel to the building line, 1 1/2 inches wide for

structures up to 300 feet in length. The width of the envelope may be increased by 1/2 inch for each additional 100 feet in length but may not exceed 3 inches.

d. The member working points of exterior columns may be displaced from the established column line, in a direction parallel to the building line, no more than 2 inches.

6. Members Other Than Columns
   a. Alignment of members containing no field splices, except cantilevered members, is acceptable if the variation in alignment is caused solely by the variation of column alignment and primary supporting member alignment or both within the permissible limits for fabrication and erection of such members.
   b. The elevation of members connecting to columns is acceptable if the distance from the member working point to the upper milled splice line of the column does not deviate more than plus 3/16 inch or minus 5/16 inch from the distance specified on the drawings.
   c. The elevation of members that consist of a single shipping piece, other than members connected to columns, is considered acceptable if the variation in actual elevation is caused solely by the variation in elevation of the supporting members that are within permissible limits for fabrication and erection of such members.
   d. Individual members that are segments of field assembled units containing field splices between points of support are considered plumb, level, and aligned if the angular variation of the working line of each member relative to the plan alignment does not exceed 1:500.
   e. The elevation and alignment of cantilevered members shall be considered plumb, level, and aligned if the angular variation of the working line from a straight line extended in the plan direction from the working point at its supported end does not exceed 1:500.
   f. The elevation and alignment of members that are of irregular shape shall be considered plumb, level, and aligned if the fabricated member is within its tolerance and its supporting member or members are within the tolerances specified.
7. Adjustable items: The alignment of lintels, wall supports, curb angles, mullions, and similar supporting members requiring limits closer than the specified tolerances shall be detailed on the Contractor's shop and erection drawings. The tolerances on position and alignment of such adjustable items are as follows.
   a. Adjustable items are considered to be properly located in their vertical position when their location is within 3/8 inch of the location established from the upper milled splice line of the nearest column to the support location as specified on the drawings.
   b. Adjustable items are considered to be properly located in their horizontal position when their location is within 3/8 inch of the proper location relative to the established finish line at any particular floor.
   c. The ends of adjustable items that abut are considered to be properly located when aligned to within 3/16 of each other both vertically and horizontally.

8. Leveling and plumbing measurements shall be established at the mean operating temperature of the structure. Procedures for measurements at specified temperatures or conditions shall be developed by the Contractor and included in the Contractor's quality control plan. Unless otherwise shown, the mean operating temperature of a structure shall be taken as 68° F.
9. The Contractor shall perform necessary adjustments to compensate for discrepancies in elevation and alignment.
10. Joint assembly (welded or bolted) shall proceed systematically from the most rigid part of the joint toward the free edges.
11. Anchor bolts shall be tightened after the supported members have been positioned and plumbed.
12. Bearing surfaces and other areas that will be in permanent contact shall be cleaned before assembly.
13. When structural framing attaches to concrete or masonry, the concrete or masonry shall reach the specified design strength before attachment unless otherwise approved by the Engineer.

D. Temporary Support of Structural Steel Frames
1. Temporary supports, such as temporary guys, braces, falsework, cribbing or other elements required for the erection operation will be determined and furnished and installed by the Contractor. Temporary supports shall secure the steel framing, or partly assembled steel framing, against loads resulting from wind, seismic forces, and erection operations.
2. Self-supporting steel frames provide required stability and resistance to gravity loads and design wind and seismic forces without interaction with other elements of the structure. The Contractor shall furnish and install only those temporary supports that are necessary to secure any element or elements of the steel framing until they are made stable without external support. Special erection sequences or other considerations that are required to provide stability during the erection process shall be determined by the Contractor and detailed on the erection drawings.
3. A non-self-supporting steel frame is one that, when fully assembled and connected, requires interaction with other elements not classified as structural steel to provide stability and strength to resist loads for which the frame is designed. Such frames shall be clearly designated as non-self-supporting. The major elements not classified as structural steel, such as steel deck diaphragms, masonry, or concrete shear walls, shall be identified in the Contractor's erection drawings.
4. When structural elements not classified as structural steel interact with the structural steel elements to provide stability or strength to resist loads, the Contractor is responsible for the installation, structural adequacy during installation, and timely completion of all such elements. The erection drawings shall specify the sequence and schedule of placement of such elements and the effects of the loads imposed on the structural steel frame by partially or completely installed interacting elements. The Contractor shall furnish and install temporary supports as it deems necessary to support structural steel elements. All temporary supports shall be designed by the Contractor and detailed on the erection drawings.

5. In self-supporting structures, temporary supports are not required after the structural steel for a self-supporting element is located and fastened within the required tolerances. After such final fastening, temporary support may be removed.
6. In non-self-supporting structures the Contractor may remove temporary supports when the necessary non-structural steel elements are complete. Temporary supports are not to be removed without the approval of the Engineer.
7. Upon completion of erection and before final acceptance, the Contractor shall remove falsework, rubbish, and temporary structures. Temporary braces shall be removed completely.
    a. Where temporary attachments have been made to the structure, welds shall be removed and the area repaired in the same manner as for a repair of a weld specified in AWS D1.1.
    b. Temporary attachments into concrete shall be removed to a point two inches below the surface of the concrete, and the surface shall be repaired as specified in Section 03 30 00.

3.3 BOLTED CONNECTIONS

A. General
1. Bolts for structural connections shall be high-strength bolts unless otherwise shown on the drawings or specified in this section.
2. Threaded fasteners where specified, shall include as a minimum a matching hardened nut and washer, as required for a complete installation, unless otherwise indicated on the Drawings.
3. Fasteners installed in oversize or slotted holes as shown on the drawings shall be provided with hardened washers at each contact surface.

B. High-Strength Bolts
1. High-strength bolted connections shall be bearing-type connections with threads excluded from the shear planes, unless otherwise noted on the drawings.
2. High-strength bolt assemblies shall be installed in accordance with the applicable provisions of the RCSC Specification.
3. Where applicable, bolts for slip-critical connections shall be tensioned by the turn-of-nut method or by alternate methods approved by the Engineer.

C. Threaded end-welded studs
1. Verify that bolt holes and slots are capable of accommodating the flash diameter of the stud plus 1/16-inch, unless otherwise noted.
2. Welding equipment, settings, and cleaning requirements during the installation shall be in conformance with the Manufacturer’s instructions and any applicable ICC-ESR reports with local requirements.
3. Refer to the Structural Drawings for field torque and field destructive hand-held hammer bend testing requirements.

3.4 REPAIR

A. Cutting torches shall not be used for field correction of fabrication errors or correction of erection problems.

B. Hole alignment errors at bolted connections or errors that require changes in member configuration shall be reported to the Engineer. Remedial work proposed for correction of errors shall be submitted to the Engineer for approval prior to being performed. Repair methods may include:
   1. Ream holes to admit bolts.
   2. Plug-weld misaligned holes and redrill holes to admit specified bolts.
   3. Drill additional holes in the connection for bolt spacing, end, and edge distance, as approved by the Engineer, and add additional bolts.
   4. Fabricate and install a new member to the correct or revised details to provide proper fit.

C. Repair of misalignment between anchor bolts and bolt holes shall be by procedures developed by the Contractor and approved by the Engineer.

3.5 FIELD PAINTING AND COATING

A. Coating shall be performed in accordance with the Architectural Drawings except otherwise shown on the drawings.

B. After erection, field welds, and field bolts, damaged portions of shop-painted surfaces shall be cleaned and touched up in accordance with the Architectural Drawings. On surfaces to receive specific coatings, the final coats shall then be applied if not previously done in the shop.
   1. As a minimum, for interior structural steel to remain primered only, exposed portions of bolts and welds shall receive 2-coats of zinc rich epoxy primer to match the coating of the primered structural steel.

C. Galvanized surfaces shall be repaired in accordance with Section 05 50 00.

3.6 SHOP AND FIELD QUALITY CONTROL

A. Welding Inspections
   1. Fabrication, erection inspection, and testing as defined in AWS D1.1 are the responsibility of the Contractor. Verification inspection will be performed by the Engineer. Verification inspection may be made in the shop during fabrication, after delivery to the jobsite, and during erection.
   2. Nondestructive testing (NDT) of welds shall be performed by the Contractor in accordance with the mandatory requirements of AWS D1.1 with the following additional requirements:

a. Qualification of Weld Testing Personnel: Nondestructive testing (NDT) personnel shall, as a minimum, be NDT Level II in accordance with ASNT SNT-TC-1A.
b. Complete joint penetration welds shall be tested by radiographic or ultrasonic methods. Acceptance criteria shall be in accordance with AWS D1.1.
c. All welded moment-resisting, steel beam-column connections shall be continuously inspected and tested by nondestructive methods, using either radiographic or ultrasonic methods. These welds shall be 100 percent tested in accordance with AWS D1.1, Inspection, Radiographic Testing of Groove Welds in Butt Joints, and Ultrasonic Testing of Groove Welds.
d. Base metal thicker than 1-1/2 inches shall be ultrasonically inspected for discontinuities directly behind welds after joint completion.

END OF SECTION

SECTION 05 40 00 – COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Furring
   2. Stud framing.
   3. Specialty framing.
   4. Connectors.
   5. Wall backings.
   6. Slot metal channel framing.
   7. Delegated design of framing.
   8. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

B. Related Requirements:
   1. Section 09 22 16 for lightgage metal framing.
   2. Section 09 22 26 for metal suspension systems.

1.2 REFERENCES

A. Abbreviations and Acronyms:
   1. AISI: American Iron and Steel Institute.
   2. AWS: American Welding Society.
   3. BMT: Base Metal Thickness.msg
   4. MSG: Manufacturer’s Standard Gage for Sheet Steel.
   5. HDG: Hot Dip Galvanized.

B. Definitions:
   1. Manufacturer: Means the metal framing manufacturer, unless otherwise indicated.
   2. Metal Framing: Means cold-formed metal framing.
   3. Gage: Means the thickness of sheet metal based on weight measured in pounds per square foot per inch of thickness. For the purposes of this specification, gages are classified the Table below. Minimum thickness indicated in the first column is equivalent to 95 percent of the design thickness and is the minimum acceptable thickness of base metal delivered to the project site.
   4. Manufacturers' Standard Gage for Sheet Metal: Means the steel sheet thickness based on a weight of 41.82 pounds per square foot per inch of thickness.

5. Base Metal Minimum Thickness: Means the thickness of sheet steel material without any coatings.
6. Lightgage Metal Framing: Means metal framing members having a BMT of 30 mils BMT (MSG 20) or less and installed in non-load bearing interior construction assemblies typically supporting plaster or gypsum board.
7. Cold-Formed Metal Framing: Means metal framing members having a BMT range of between 118 mils BMT (MSG 10) and 33 mils BMT (MSG 20) and installed in transverse or axial load-bearing applications, or in non-load bearing interior construction assemblies typically supporting plaster or gypsum board.

Reference Gage	Minimum Thickness (mils)	Design Thickness (inch)
Lightgage Metal Framing specified in Section 09 22 16		
25	18	0.0188
22	27	0.0283
20	30	0.0312
Cold-Formed Metal Framing specified in this specification Section		
20	33	0.0346
18	43	0.0451
16	54	0.0566
14	68	0.0713
12	97	0.1017
10	118	0.1242

1.3 ADMINISTRATIVE REQUIREMENTS

A. Delegated Design Requirements:
1. Engineer, fabricate, assemble, and install framing that conforms to the profiles indicated and other Contract Document requirements; meets specified performance criteria; and results in structurally sound, non-corroding, and weathertight assemblies that accommodate, resist, distribute, or transfer in-service loads without incipient or catastrophic failure.
2. Maintain visual design concept indicated, including sizes, profiles, and alignments. Deviation from visual design concept is non-conforming work and prohibited without prior written acceptance by the Architect.

B. Performance Requirements:

1. Exterior Wall Design Pressure: Calculate in conformance with American Society of Civil Engineers/ Structural Engineering Institute publication ASCE/SEI 7, "*Minimum Design Loads and Associated Criteria for Buildings and other Structures*".
2. Interior Partition Uniformly Distributed Lateral Live Load: At least 10 pounds per square foot.
3. Superstructure Displacement:
   a. Vertical Displacement of Adjacent Stories (Live Load Deflection): Allow for at least 3/4-inch vertical live load structure deflection, unless otherwise indicated on the structural drawings and general notes.
   b. Horizontal Displacement of Adjacent Stories (Interstory Drift): Accommodate design displacement of adjacent stories indicated on the structural drawings and general notes.
4. Seismic Loads: Resist, distribute, or transfer seismic loads indicated on the structural drawings without incipient or catastrophic failure.
5. Perpendicular Deflection (Convexity and Concavity): Framing members may not deflect more than shown in California Building Code Table 1604A.3 or the following, whichever is less, measured normal to the assembly plane. Limit asymmetric wall construction deflection to the most stringent requirement that applies to the assembly.
   a. Construction Supporting Masonry: Not more than L/600.
   b. Construction Supporting Stone: Not more than L/720.
   c. Construction Supporting Wall Panels: Not more than L/180.
   d. Construction Supporting Plaster: Not more than L/360.
   e. Construction Supporting Gypsum Board: Not more than L/240.
   f. Construction Supporting Tile: Not more than L/360.
6. Thermal Expansion and Contraction: Accommodate movement resulting from at least 120 deg. F ambient and 180 deg. F material surface temperature differentials. (changes)
7. Dissimilar Metal Corrosion Protection: Permanently isolate metal surfaces from direct contact with incompatible materials and other potentially corrosive substrates as specified in Section 05 50 10.

1.4 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data: Submit manufacturer's product data, specifications, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs) and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
   2. Shop Drawings: Include project-specific dimensioned details drawn to scale showing framing conditions not detailed on the product data or indicated on the Drawings; or that are detailed, but not in a manner specific to the project.

a. Show layouts, spacings, sizes, thickness, and types of metal framing, including reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, and accessories.
b. Show fasteners brackets, clips, and attachments to other work, including seismic bracing and slab edge conditions. Label each attachment type by manufacturer's product name. Show base material and finish, fastener material and finish, and material and finish of items being fastened or attached.
c. Show head of wall connections for fire-resistance rated assemblies, framed opening details, acoustical seals and tie-in conditions to fireproofing, and inside and outside corner conditions.

B. Informational Submittals: Submit the following for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
1. Manufacturer's Instructions: Submit manufacturer-prepared published instructions for proper installation of furnished framing.
a. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.
b. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.
2. Delegated Design Submittals: Together with shop drawings, submit engineering calculations demonstrating conformance to the Contract Documents and all impacts of delegated design scope of work on other work.
a. Calculations must be explicit and legible and must incorporate distinct cross-references to submitted shop drawings in sufficient quantity to render the calculations readily intelligible and reviewable.
b. At a minimum, calculations must include design loads; analysis of supporting construction, including section-property computations; analysis of fasteners, anchors, attachments, and connectors; and signature and seal of the licensed professional engineer responsible for preparing them.
c. Test reports are not an acceptable substitute for calculations and are returned to the Contractor without review or responsive action, except to record non-conformance with this requirement.
3. Qualification Statements: Submit written descriptions confirming experience specified in QUALITY ASSURANCE article below.

1.5 QUALITY ASSURANCE

A. Source Limitations:
1. Framing must be obtained through one source from the same manufacturer (to ensure compatibility, regulatory conformance, and a warrantable installation).
a. Certain items may be obtained from more than one manufacturer, but only when used for separate installations.

b. Items provided for each different installation must be obtained from the same source and manufacturer.

2. Provide secondary materials, components, accessories and other items from sources required, recommended, or accepted by the primary manufacturer for actual in-service conditions applicable to the project.

B. Quality Standards:

1. Design Standards:
   a. Comply with all requirements of the California Building Code (CBC).
   b. Comply with the requirements AISI publications S100, "*North American Specification for the Design of Cold-Formed Steel Structural Members"* and SG03 "*Cold-Formed Steel Design Manual"* for cold-formed steel framing design.
2. Material Standards:
   a. Comply with the requirements of AISI publication, "*Standard for Cold-Formed Steel Framing - General Provisions"*.
   b. Comply with the requirements of AISI publication, *"Standard for Cold-Formed Steel Framing - Header Design"*.
3. Welding Standards: Welding procedures must conform to the requirements of the following American Welding Society publications.
   a. AWS D1.3, "*Structural Welding Code – Sheet Steel*".
   b. AWS D9.1, "*Sheet Metal Welding*".
   c. AWS D19.0, "*Welding Zinc Coated Steel*".

C. Qualifications:

1. Installer: Company or individuals must have at least 5 years' experience installing framing for at least 30 previous projects similar to this project in size, material, design, and complexity.
2. Welders: Welding personnel and supervisors must comply with, and welding procedures must conform to, the "*Qualification*" requirements of American Welding Society publications AWS D1.3, "*Structural Welding Code – Sheet Steel*" and AWS D19.0, "*Welding Zinc Coated Steel*" applicable to the project. Only certified welders current in their certification may perform or supervise any welding work.
3. Supervisors: Individuals must have at least 7 years' experience installing framing for at least 30 previous projects similar to this project in size, material, design, and complexity, including at least 2 years' supervisory experience directing and leading framing installers.
4. Engineer: Must be a licensed professional structural engineer registered to practice in California having at least 10 years' experience performing the kind of engineering services indicated for at least 20 previous projects similar to this project in size, material, design, and complexity.

D. Mockups: If an *ex-situ* exterior wall integrated mockup is required for this project, then integrate framing into the mockup as part of the work of this specification section.

1.6 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
   1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
   2. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items as shipped and in conformance with manufacturer's instructions and other requirements and recommendations for storage. Furnish adequate dunnage and bracing during storage.
   1. Prevent stored items from contacting the floor or ground, from soiling and staining, and from deterioration and damage.
   2. If items are not stored in an enclosed location, then cover the tops and sides with securely-tied, waterproof, and breathable covers. Unvented polyethylene tarpaulins do not qualify as breathable covers and are prohibited. (due to potential accumulation of moisture beneath tarpaulin during certain environmental conditions)
   3. Incline covered items to ensure maximum drainage of accumulated moisture.
   4. Do not leave items uncovered where they might be exposed to weather or become wet; or exposed to other sources of deterioration and damage.

C. Handling: Handle items in conformance with manufacturer's instructions and other requirements and recommendations, and in a manner that that prevents damage.

D. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective framing with undamaged new framing that does not exhibit deterioration, damage, or defects.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide products manufactured by one of the following, or equal.
   1. California Expanded Metal Products Co. (CEMCO)
   2. Clarkwestern Dietrich Building Systems LLC.
   3. Olmar Supply Inc.
   4. SCAFCO Corp.

2.2 MATERIALS

A. HDG Metallic-Coated Steel Sheet for Cold-Formed Framing: ASTM A 1003, ST50 (Structural Grade 50), with at least a G60 coating weight designation (mass designation) on both surfaces with equal coating weight on each surface.

2.3 COLD-FORMED FURRING

A. Hat Furring Channels:
   1. Products: “FC Series Furring Channel” manufactured by Clarkwestern Dietrich Building Systems LLC, or equal.
   2. Requisite Properties:
      a. Depth: 7/8- or 1-1/2-inch deep channels, as indicated.
      b. Minimum Thickness: At least 43 mils BMT (MSG 18).
      c. Web: 1-1/4 inches wide.
      d. Screw Flanges: 3/4-inch wide.

B. Z-shaped Furring Channels:
   1. Products: “Z-Furring (ZF-Series)” manufactured by Clarkwestern Dietrich Building Systems LLC, or equal.
   2. Requisite Properties:
      a. Depth: One to 3 inches deep, as indicated.
      b. Minimum Thickness: At least 43 mils BMT (MSG 18).
      c. Screw Flanges: 1-1/4 inches wide.

2.4 COLD-FORMED STUD FRAMING

A. Studs:
   1. Description: Pre-punched roll-formed C-shaped framing members with manufacturer’s standard knockout sizing and spacing.
   2. Product: “Structural Stud S162 (CSJ)” manufactured by Clarkwestern Dietrich Building Systems LLC, or equal. (ICC ES Report No. ESR-1166P and Los Angeles Research Report No. RR 25889)
   3. Requisite Properties:
      a. Depth: Indicated on the Drawings.
      b. Minimum Thickness: At least 54 mils BMT (MSG 16).
      c. Flanges: At least 1-5/8-inch (1-3/8- to 3) wide stiffened flanges with at least 1/2-inch returns (lip).

B. Tracks (Top and Bottom Runners):
   1. Description: Un-punched roll-formed U-shaped runners manufactured from the same material to corresponding stud sizes and gages.

2. Product: "Structural Track" manufactured by Clarkwestern Dietrich Building Systems LLC, or equal. (ICC ES Report No. ESR-1166P and Los Angeles Research Report No. RR 25889)
3. Requisite Properties:
   a. Depth: Indicated on the Drawings.
   b. Minimum Thickness: At least 54 mils BMT. (MSG 16)
   c. Flanges: At least 1-1/2-inch wide unstiffened flanges.

C. Deflection Track Systems:
1. Description: Slotted roll- or brake-formed track installed in head-of-wall deflection conditions to accommodate vertical movement caused by normal head-of-wall and floor extension or compression.
2. Product: one of the following, or equal.
   a. "MaxTrack" slotted deflection track or "BlazeFrame" fire stop deflection track manufactured by Clarkwestern Dietrich Building Systems LLC. (Intertek Code Compliance Research Reports No. CCRR-0205)
   b. "CEMCO Slotted Track (CST)" manufactured by CEMCO.

D. Manufactured Bridging Channels:
1. Description: Roll-formed channel- or L-shaped stiffeners with pre-notched slots installed in both load-bearing and non-load bearing walls to help resist stud twisting.
2. Products: "Spazzer 5400" manufactured by Clarkwestern Dietrich Building Systems LLC, or equal.
3. Requisite Properties:
   a. Size: 1-1/2-inch wide by 1/2-inch deep.
   b. Minimum Thickness: At least 54 mils BMT (MSG 16).
4. Bridging Clips: "Spazzer Bar Guard" manufactured by Clarkwestern Dietrich Building Systems LLC, or equal.
5. Alternative Bridging Clips: As an alternate to manufactured bridging clips, 1-1/2-inch wide by 1/2-inch deep by full stud width cold-rolled angle clips manufactured from at least 54-mil (MSG 16) BMT HDG metallic-coated steel sheet may be provided.

E. Cold Rolled Channel (CRC) Bridging:
1. Description: Un-punched roll-formed U-shape stiffeners installed in both load-bearing and non-load bearing walls to help resist stud twisting.
2. Requisite Properties:
   a. Size: 1-1/2-inch wide by 1/2-inch deep.
   b. Minimum Thickness: At least 54 mils BMT (MSG 16).
   c. Flanges: 1-1/2 inches wide unstiffened flanges.
3. Manufactured Bridging Clips: "EasyClip U-, B-, or X-Series Clip Angles" manufactured by Clarkwestern Dietrich Building Systems LLC, or equal.

F. Flat Strap Bridging (Strapping):

1. Application: Flat sheet installed to provide resistance to stud rotation and minor axis buckling under loads for studs deeper than 6 inches.
2. Requisite Properties:
   a. Width: Between 2 and 20 inches, as indicated or necessary.
   b. Minimum Thickness: At least 54 mils BMT (MSG 16).

G. Built-Up Headers:
1. Built-Up Curtain Wall Headers: Un-punched roll-formed C-shaped framing members and U-channel runners.
2. Load-Bearing Box Beam Headers: Un-punched roll-formed C-shaped framing members.
3. Requisite Properties:
   a. Depth: Indicated on the Drawings.
   b. Minimum Thickness: At least 54 mils BMT (MSG 16).
   c. Flanges: 1-5/8-inch wide stiffened flanges with at least 1/2-inch returns (lip).
4. Header Connectors:
   a. Description: Connectors to attach either beams to columns or headers to jambs.
   b. Product: “DROP'N LOCK CLIP” connectors manufactured by Clarkwestern Dietrich Building Systems LLC, or equal.

2.5 SPECIALTY FRAMING

A. KCS Studs (King Kong Studs):
1. Description: Pre-punched C-shaped framing members with manufacturer’s standard knockout sizing and spacing.
2. Requisite Properties:
   a. Depth: Indicated on the Drawings.
   b. Minimum Thickness: At least 54 mils BMT (MSG 16).
   c. Flanges: 3-inch wide stiffened flanges with at least 7/8-inch returns (lip).

B. Manufactured Headers:
1. Description: One- or 2-piece pre-engineered header with associated inserts and clips.
2. Products: one of the following, or equal.
   a. “RedHeader RO Rough Opening System” manufactured by Clarkwestern Dietrich Building Systems LLC.
   b. “Pro-X” manufactured by Brady Construction Innovations, Inc.

C. Corner Angles:
1. Description: Utility angles installed as a connection strut or angle, as corner reinforcement, or other various framing applications.
2. Requisite Properties:
   a. Minimum Thickness: At least 30 mils BMT (MSG 20).

b. Legs: 2- or 3-inch wide legs, as indicated, unless a wider or uneven leg size is explicitly indicated; or is otherwise supplied, required, recommended, authorized, or accepted by the manufacturer.

2.6 CONNECTORS

A. Bypass Connectors:
   1. Description: Clips used to attach exterior curtain wall studs to building superstructure and to provide vertical building movement independent of metal stud framing.
   2. Bypass Slab Connectors: “Slide Clip” (minimal or no standoff conditions) or “Fast Clip Slide Clip” (medium standoff conditions) manufactured by Clarkwestern Dietrich Building Systems LLC, or equal.
   3. Bypass Structure Connectors: “Quick Clip” (medium standoff conditions) and “Extended Fast Clip Slide Clip” or “Fast Strut” (large standoff conditions) manufactured by Clarkwestern Dietrich Building Systems LLC, or equal.

B. Multipurpose Connectors Rigid Connectors: “Uni-Clip” manufactured by Clarkwestern Dietrich Building Systems LLC, or equal.

2.7 WALL BACKINGS

A. Metal Wall Backings:
   1. Description: General multipurpose flat sheet and formed metal stock used as backing to support shelves, cabinets, fixtures or handrails when applied to framing. Provide wall backing in addition to, not as a replacement for, tension strapping or cross bracing.
   2. Heavy-Duty Backing: Installed to support items distributing not more than 80 pounds per stud.
      a. Material: 6-inch wide un-punched U-shaped runners manufactured from minimum 54-mil BMT (MSG 16) HDG metallic-coated steel sheet.
      b. Provide individual runner in lengths long enough to span across at least 3 studs.
      c. Notch and bend track legs so that backing plate is flush with exterior face of stud.
      d. Do not cut track legs between supporting studs.
      e. Fasten backing track to each stud with at least 3 screw fasteners per stud.
   3. Medium-Duty Backing: Installed to support items distributing not more than 20 pounds per stud.
      a. Material: Minimum 6-inch wide un-punched U-shaped runners manufactured from minimum 54-mil BMT (MSG 16) HDG metallic-coated steel sheet.
      b. Provide individual runner in lengths long enough to span across at least 2 studs.
      c. Fasten backing track to each stud with at least 3 screw fasteners per stud.
   4. Light-Duty Backing: Installed to support items distributing not more than 5 pounds per stud.

a. Backing Material: Minimum 6-inch wide backing strip manufactured from minimum 54-mil BMT (MSG 16) HDG metallic-coated steel sheet.
b. Provide individual runner in lengths long enough to span across at lreast 3 studs.
c. Fasten backing track to each stud with at least one screw fasteners per stud.

B. Wood Wall Backings:
1. Description: Fire-retardant treated wood (FRT) backing system.
2. Product: “Danback Flexible Wood Backing System” manufactured by Clarkwestern Dietrich Building Systems LLC, or equal.
3. Requisite Properties:
a. Material: Nominal 3/4-inch thick CDX Douglas fir fire-retardant treated wood
b. Dimensions: 48 inches long by 5-1/8 inches high.

2.8 SLOT METAL CHANNEL FRAMING

A. Description: Continuous slot metal channel framing conforming to MFMA-4, and associated fittings and hardware necessary for supporting cable trays, conduit, pipes and similar items.

B. Material: At least 0.0747-inch BMT (MSG 14) HDG metallic-coated steel sheet complying with ASTM A 653, structural steel (SS), Grade 33 or better, at least a G90 zinc coating designation on both surfaces with equal coating weight on each surface.

C. Manufacturers: Provide products manufactured by one of the following, or equal.
1. Flex-Strut, Inc.
2. PHD Manufacturing, Inc.
3. Unistrut Corp.

D. Product: “P300 SL” manufactured by Unistrut Corp., or equal.

E. Requisite Properties:
1. Types: standard and welded combination channels as required by conditions of installation and service.
2. Height: heights as required by engineering calculations to meet load capacities, but not less than 1-3/8 inches.
3. Suspension System: Hot-dip galvanized coarse-threaded (UNC) carbon steel rods having diameters as required by engineering calculations to meet load capacities, but not less than 3/8-inch.

F. Accessories: kickers, perimeter angle pieces and other accessories as supplied, required, recommended, or accepted by the slotted channel framing manufacturer and necessary for a complete and structurally-sound installation.

G. Finish: Chemically treated where retaining natural zinc finish; bonderized where painted finish is indicated.

2.9 ACCESSORIES

A. Sill Sealer and Liner Gaskets:
   1. Description: Self-adhering closed cell polyethylene foam air and moisture barrier.
   2. Applications:
      a. Sill Sealer: Install on the top of foundation wall, slab-on-grade. or curbs beneath exterior wall runner track or sill plates.
      b. Plate Liner: Install between floor deck and interior wall runner track or sill plates at shafts, hoistways, and other locations where necessary or indicated.
   3. Products: the following products manufactured by Protecto Wrap Co.
      a. Sill Sealer: 3/8-inch thick “Protecto Triple Guard Energy Sill Sealer”, or equal.
      b. Plate Liner: 1/4-inch thick “Protecto Energy Plate Liner”, or equal.

B. Shims: Load bearing, non-leaching, high-density multimonomer plastic.

C. Screw Fasteners: #8- and #10-32 UNC 2B (0.164- and 0.190-inch shank diameter, 32 threads per inch) by at least one-inch long, pan head, coarse thread, self-drilling uncoated bi-metal screw fasteners, unless another fastener type is explicitly indicated; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

D. Power-Actuated Fasteners:
   1. Description: ICC-ES-approved anchors conforming to California Building Code Occupancy Category III, Seismic Design Category E, unless a more stringent Occupancy Category or Seismic Design Category is indicated on the Structural Drawings.
   2. Manufacturer: Provide products manufactured by Hilti, Inc., or equal.

E. Fastenings: backings, inserts, loose connection hardware, fasteners, anchors, attachments, connectors, and other items supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

F. Other Accessories: Provide other accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification: Verify in-place supporting and adjacent construction conforms to the manufacturer's requirements or recommendations and satisfies all other conditions that might affect the quality of installation or the durability, appearance, or performance of installed and adjacent items.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.
   2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 INSTALLATION

A. General Requirements:
   1. Install framing using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
   2. Installed framing must be warrantable. Do not install, correct, or replace framing in a manner that results in any warranty or guarantee becoming void.

B. Metal Furring Special Techniques:
   1. Direct Furring: Attach to concrete or to masonry with stub nails, screws designed for masonry attachment, or power-actuated fasteners spaced 24 inches on center.
   2. Z-Furring:
      a. Except at outside corners, securely attach narrow flanges of furring members to walls with concrete stub nails, screws designed for masonry attachment, or power-actuated fasteners spaced 24 inches on center.
      b. At outside corners, attach wide flange of furring members to walls with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.

C. Metal Framing Special Techniques:
   1. Align and securely attach floor and ceiling tracks to superstructure.
   2. Install studs in single lengths extending from floor to underside of floor or roof structure above without joints, except where indicated on the Drawings as stopping at or above ceilings. Stud splicing is prohibited without prior written authorization from the Architect.
      a. Install studs so that flanges within framing systems point in same direction.
      b. Continue framing around ducts that penetrate partitions above ceilings.
      c. Where framing extends to overhead structural supports, install vertical deflection connectors to produce joints at tops of framing assemblies that prevent axial loading of finished assemblies.

d. Where studs stop at or above ceilings, brace not more than every fourth stud with opposite-side bracing installed at 45-degree angles and securely fastened to the underside of the floor or roof structure above.
e. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.
f. Assemble corners using at least 3 studs.

3. Unless otherwise indicated, provide screw attachment to tracks for
   a. studs with gypsum board on only one side;
   b. studs on each side of doors and windows;
   c. studs supporting wall hung plumbing fixtures; and
   d. studs supporting wall hung urinal screens, toilet compartments, cabinets, equipment, and similar items.
4. Attach all other studs to tracks either by friction fit for single stud gypsum board partitions or by attaching with screws in conformance with the manufacturer's published installation instructions.
   a. Space anchors within 6 inches of ends of each track segment ends, and not more than 24 inches on center.
   b. Do not install fasteners within 3 inches of slab or curb edges.
5. Where required by engineering calculations, install horizontal bridging spaced not more than 54 inches on center. Unless otherwise indicated, provide bridging in partitions supporting wall supported cabinets.
   a. Tack-weld stiffeners to each stud.
   b. Provide an additional 3/4 inch channel 6 inches above door headers, and extend at least 3 studs beyond the jamb studs.
   c. Install channels in longest possible lengths. At end joints, lap at least 12 inches and wire-tie. Do not tie together channels on opposite sides of staggered or double stud partitions.

D. Door and Window Opening Special Techniques:
1. Provide double studs (installed face to face to form a tube) at locations adjacent to doors and openings.
2. Extend studs at door openings to slab or deck above and securely anchor both to bottom track and to top slab or deck.
3. Locate additional studs not more than 2 inches from door and window frames, abutting partitions, partition corners, and other construction.
4. Install sections of track over door and window frames with clip angles securely attached at each end to adjacent vertical studs. Install cut-to-length studs at vertical joint locations; and at standard spacing over the door frame header extending to the ceiling track.
5. Install cripple studs at opening heads adjacent to each jamb stud, with at least a 1/2 inch clearance from the jamb stud to allow for installation of control joint in the finished assembly.

E. Other Opening Special Techniques: Unless otherwise indicated, frame other openings and recesses in stud walls the same as that required for door openings.
   1. Install framing below sills matching framing required above door heads.
   2. Provide additional framing as required for the secure attachment of electrical boxes, fire extinguisher cabinets, and similar items located in stud walls.

F. Backing Plate Special Techniques:
   1. Install supplementary framing and backing plates to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction. Wall-mounted and wall-hung items that require backing plates include the following.
      a. Ladders.
      b. Cabinets.
      c. Door stops.
      d. Toilet compartments and screens.
      e. Toilet accessories.
      f. Grab bars.
      g. Plumbing fixtures.
      h. Other items when indicated.
   2. Backing plates may be omitted if anchorage for wall-hung items is directly attached to at least 43-mil BMT (MSG 18) or heavier HDG metallic-coated cold-formed metal studs; or if the items are furnished with equivalent mounting devices.

G. Interface with Adjacent Items: Provide materials, components, and accessories normally furnished or necessary to securely attach framing to supporting construction.

H. Installation Tolerances: Install framing within the following tolerance variations.
   1. Maximum Out of Plumb: Not more than L/960 of span, or 1/8-inch in 10 feet.
   2. Maximum Out of Level: Not more than L/960 of span, or 1/8-inch in 10 feet,
   3. Maximum Out of Plane: Fastening surfaces of adjacent framing members may not vary by more than 1/8-inch.
   4. Maximum Stud Spacing Variance: Not more than 1/8-inch. Cumulative error may not exceed minimum fastening requirements of sheathing or other finishing materials.

3.3 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include

1. written descriptions of non-conforming, damaged, and defective work;
2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.4 CLEANING

A. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

END OF SECTION

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SECTION 05 50 00 – METAL FABRICATIONS

PART 1 - GENERAL

1.1 REFERENCES

A. General
   1. The publications listed below form a part of this specification to the extent referenced.
   2. Where a date is given for reference standards, the edition of that date shall be used. Where no date is given for reference standards, the latest edition available on the date of Notice Inviting Bids shall be used.

B. American Institute of Steel Construction (AISC)
   1. ANSI/AISC 360, Specification for Structural Steel Buildings
   2. AISC Steel Construction Manual

C. ASTM International (ASTM)
   1. ASTM A6, Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
   2. ASTM A29, Standard Specification for Steel Bars, Carbon and Alloy, Hot-Wrought, General Requirements for
   3. ASTM A36, Standard Specification for Carbon Structural Steel
   4. ASTM A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
   5. ASTM A108, Standard Specification for Steel Bars, Carbon and Alloy, Cold-Finished.
   6. ASTM A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
   7. ASTM A143, Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
   8. ASTM A153, Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware
   9. ASTM A193, Standard Specification for Alloy Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
   10. ASTM A194, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High-Temperature Service, or Both
   11. ASTM A276, Standard Specification for Stainless Steel Bars and Shapes
   12. ASTM A283, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
   13. ASTM A307, Standard Specifications for Carbon Steel Bolts, Studs, and Threaded Rod (60,000 psi Tensile Strength)

14. ASTM A312, Standard Specification for Seamless Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
15. ASTM A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
16. ASTM A384, Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
17. ASTM A500, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
18. ASTM A554, Standard Specification for Welded Stainless Steel Mechanical Tubing
19. ASTM A563, Standard Specification for Carbon and Alloy Steel Nuts
20. ASTM A564, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
21. ASTM A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
22. ASTM A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
23. ASTM A786, Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates
24. ASTM A992, Standard Specification for Structural Steel Shapes
25. ASTM A1008, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
26. ASTM B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
27. ASTM B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
28. ASTM B633, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
29. ASTM D7091, Standard Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals
30. ASTM F436, Standard Specification for Hardened Steel Washers
31. ASTM F467, Standard Specification for Nonferrous Nuts for General Use
32. ASTM F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, Socket Head Cap Screws, and Studs for General Use
33. ASTM F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
34. ASTM F594, Standard Specification for Stainless Steel Nuts
35. ASTM F844, Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
36. ASTM F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

D. American Society of Mechanical Engineers (ASME)
   1. ANSI/ASME B1.1, Unified Inch Screw Threads

E. American Welding Society (AWS)
   1. AWS A5.4, Specification for Stainless Steel Electrodes for Shielded Metal Arc Welding
   2. AWS A5.9, Specification for Bare Stainless Steel Welding Electrodes and Rods
   3. AWS A5.10, Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods
   4. AWS B2.1 Specification for Welding Procedure and Performance Qualification
   5. AWS D1.1, Structural Welding Code, Steel
   6. AWS D1.2, Structural Welding Code, Aluminum
   7. AWS D1.6, Structural Welding Code, Stainless Steel
   8. AWS D10.4, Recommended Practices for Welding Austenitic Chromium-Nickel Stainless Steel Piping and Tubing
   9. AWS D10.12, Guide for Welding Mild Steel Pipe

F. International Code Council (ICC)
   1. California Building Code (CBC)
   2. Evaluation Service (ICC-ES) Reports (ESR)

G. Society for Protective Coatings (SSPC)
   1. SSPC SP-3, Power Tool Cleaning
   2. SSPC SP-5, White Metal Blast Cleaning

1.2 SUBMITTALS

A. Shop Drawings
   1. Before beginning fabrication of structural steel, the Contractor shall submit complete shop and erection drawings showing details of methods, materials, tolerances on adjustable connections, and finishes. Shop drawings shall give complete information necessary for the fabrication and erection of the component parts of the structure including the location, type, and size of all welds and bolts. Drawings shall clearly distinguish between shop or field welds and bolts.
   2. Separate plans for the setting of anchors and bearing plates, prepared in coordination with concrete placement drawings, shall be submitted and approved prior to the placement of concrete.

B. Weld Procedure Qualifications
   1. Welding Procedure Specifications (WPS) shall be submitted per AWS D1.6 or AWS D1.2 as applicable. Pre-qualified procedure may be submitted. The WPS forms shall be per AWS.

2. Welder, Welding Operator, and/or Tack welder Qualification Test Records shall be submitted on Form NE-4 of AWS D1.1 for approval for all welding personnel proposed for employment on the project.
3. Test shall be in accordance with AWS D1.1 and shall be made using the positions to be used in the work.
4. Weld material Manufacturer certifications demonstrating compliance with AWS A5.
5. The Engineer may require additional test plates as the work progresses and may demand the removal from the project of any welder whose work is not satisfactory, regardless of the quality of the test welds.
6. ICC-ES reports for self-drilling screws shall be submitted.

C. Prior to the start of fabrication, the Contractor shall establish and submit an identification system for marking of material ordered to special requirements and for field identification of assemblies and assembly components.

D. Mill test reports in accordance with ASTM A6 for all structural steel.

E. Fabricator certification for shop welding.

1.3 QUALITY ASSURANCE

A. Welder Qualifications: Welding welder qualification requirements and welding procedures shall be in accordance with AWS D1.1.
1. In lieu of performing welding operator or tack welder qualification tests, the Contractor may employ personnel possessing a current AWS certification in accordance with ASW D1.1.

B. Records of steel manufacturer shall be kept, materials shall be properly identified, and shop fabrication records shall show that the proper material was incorporated into each item. Such records shall be available to the Engineer upon request.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Erection and identification marks shall be applied to the members by painting or other suitable means, unless otherwise specified or approved by the Engineer.

B. The Contractor shall take reasonable care in the proper handling and storage of articles or materials during erection operations to avoid accumulation of dirt and foreign matter. The Contractor shall remove from the articles or materials, dust, dirt, or other foreign matter that accumulates during construction. Coated surfaces shall be protected from abrasion or other damage during handling, storing, and erecting.

C. Materials taken from stock shall comply with the appropriate ASTM standards, including the applicable test reports, prepared at the mill where the material was manufactured, or at a testing laboratory approved by the Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Carbon Steel
   1. Carbon steel bars, shapes, and plates shall be in accordance with ASTM A36, ASTM A108, ASTM A283, or ASTM A992 with a minimum yield of 36ksi.
   2. Steel tubing in rounds and shapes shall be in accordance with ASTM A500 Grade B.
   3. Pipe (including handrails, pipe columns, and light standards) shall be in accordance with ASTM A53, Grade B
   4. Light gauge galvanized sheet metal shall be in accordance with ASTM A653 CS Type B with a G90 coating, cold rolled.
   5. Cold-rolled sheet metal shall be in accordance with ASTM A1008, commercial steel.

B. Stainless Steel
   1. Unless otherwise shown on the drawings, materials in contact with water, intermittently or continuously, or in a wet or moist environment shall be stainless steel.
      a. Stainless steel bars and shapes shall be in accordance with ASTM A276 Type 316 Condition A, or Type 316L Condition A where welding is required, unless otherwise specified or shown on the drawings.
      b. Pipe shall be in accordance with ASTM A312 Type 316L.
      c. Tubing specified by outer diameter and thickness shall be in accordance with ASTM A554 Grade MT316L.
   2. Where age-hardened stainless steel is shown on the drawings, the steel shall be in accordance with ASTM A564 Type 630, cold finished. Heat-treatment or age hardening shall be conducted at 900°F, except bolts and shafts, which shall be age-hardened at 1150°F.
   3. Spring nuts, bolts, and other materials shall not be fabricated using powder metallurgy (PM) methods.

C. Aluminum
   1. Aluminum bars, plate, and shapes shall be in accordance with ASTM B221 Alloy 6061 or Alloy 6063. Temper designation shall be as shown in the drawings.
   2. Aluminum plate shall be in accordance with ASTM B209 Alloy 5052 or Alloy 6061. Temper designation shall be as shown in the drawings.

D. Fasteners
   1. Threads for bolts and nuts shall be in accordance with ANSI B1.1.
      a. Threads for bolts 1 inch and less in diameter shall be coarse-thread series and threads for bolts 1-1/8 inches and greater in diameter shall be the 8-pitch thread series.
      b. The fit shall be Class 2 free fit; except that Class 3 medium fit shall be provided in holes tapped for studs.

2. Unless otherwise shown on the drawings, bolts shall have heavy hexagon heads and heavy hexagon nuts.
3. The lengths of studs and bolts, excluding anchor bolts, shall provide a projection of not less than 1/4 inch or more than 1/2 inch through the nut when it is drawn tight; however, in exposed locations the projection shall be not more than 1/4 inch. Where the Structural Drawings specifically permit alternate reduced thread extension requirements, the Drawings shall control.
4. Bolts and other threaded fasteners where specified, shall include a matching hardened nut and washer as a minimum, as required for a complete installation, unless otherwise indicated on the Drawings.
5. Carbon Steel Fasteners, Anchor Bolts, Machine Bolts, and Threaded Rods
   a. Machine bolts, and threaded rods shall be heavy hex and in accordance with ASTM A307 Grade A, with Supplement S-1 where welding is required, unless otherwise shown.
   b. Anchor bolts: ASTM F1554 Grade 36, unless otherwise noted, hex-headed anchor bolts. The use of J-bolts is prohibited.
   c. Nuts shall be in accordance with ASTM A563 Grade A heavy hex.
   d. Hardened washers shall be in accordance with ASTM F436 Type 3. Bolt length shall be increased where hardened washers are used.
   e. Provide heavy gage oversized washers where specifically indicated, and for steel to-steel connections using end-welded threaded studs that require larger diameter holes and slots to accommodate the stud weld flash region.
6. Stainless Steel Fasteners
   a. Except as otherwise specified or shown on the drawings, stainless steel fasteners shall be used where the material will be immersed in water, intermittently or continuously, or in moist-environment installations.
      1) Type 316 or 316N stainless steel fasteners shall be in accordance with ASTM A193 Grade B8MA or Grade B8MNA for bolting and stud material, and ASTM A194 Grade 8MA or Grade 8MNA for nuts. Fasteners for age-hardened stainless steel shall be manufactured in accordance with ASTM F593 and ASTM F594 Type 630.
      2) Stainless steel washers shall conform to ASTM F844 except that they shall be machined from bar stock conforming to ASTM A276 Type 316.
      3) Stainless steel fasteners shall be Type 316 or 316N unless otherwise shown on the drawings. An anti galling compound shall be applied in the fastener threads in accordance with the manufacturer's printed instructions.
7. Silicon Bronze Fasteners
   a. As shown on the drawings, silicon bronze cap screws, nuts, fasteners, and plugs shall be of copper-silicon alloy in accordance with ASTM F467 or ASTM F468 Alloy C65100 or Alloy C65500.
8. Self-Drilling Fasteners
   a. Self-drilling fastener diameter, thread form, length, head style, and drill point shall be as shown on the drawings.
   b. Acceptable Products: TEKS® Screws, ITW Buildex; or equal.

9. Provide heavy-duty oversized washers where specifically indicated, and for steel to steel connections using end-welded threaded studs requiring larger diameter holes to accommodate the weld-flash dimension.

E. Electrodes
1. Electrodes for welding carbon steel shall be in accordance with AWS D1.1 except that electrodes shall have a minimum yield of 70ksi. Electrodes for shielded metal arc welding (SMAW) shall be low hydrogen.
2. Electrodes for welding stainless steel to stainless steel shall be in accordance with AWS A5.4 or AWS A5.9 Classification E316L/ER316L.
3. Electrodes for welding stainless steel to carbon steel shall be in accordance with AWS A5.4 or A5.9 Classification E309L/ER309L or E312/ER312.
4. Electrodes for welding aluminum shall be in accordance with AWS A5.10.
   a. Alloy 6061/6063 shall be welded using ER 4043 filler metal.
   b. Alloy 5052 shall be welded using ER 5356 filler metal.

F. Welded Stud Anchors
1. Welded stud anchors shall be in accordance with AWS D1.1 and ASTM A108 and A29, Type B, Grade 1010 through 1020 cold drawn steel or low carbon mild steel, unless otherwise noted on the drawings.
   a. Stainless steel stud anchor material where specifically required shall comply with ASTM A276.
2. Welded stud anchors that are to be embedded in concrete and shown to be attached to the structural steel or plate shall be standard steel stud units intended for automatic stud welding process, furnished complete with matching nut, washer, and arc shield (ferule) of heat-resistant ceramic or equivalent.
3. All studs shall be provided with matching ferrules manufactured by the stud Manufacturer and rated for the intended use.
4. Threaded end-welded studs shall conform to the following additional requirements:
   a. Threads for structural uses shall be UNC-2A coarse thread unless otherwise noted on the Drawings or as required for nut compatibility.
   b. Where threaded studs are used for fixed or sliding slotted precast panel connections, furnish studs with a flash diameter and flash height compatible with the provided slot width, having an installed thread length as necessary to achieve the necessary bolting or length as specifically indicated on the Drawings.
   c. When bolting steel to steel, provide oversized heavy gage washers and nuts of matching finish with the threaded studs, unless otherwise indicated on the drawings.
5. Welded stud finish: welded studs fully encased on concrete shall not be finished or zinc coated unless specifically indicated. Threaded studs and other fusion-welded anchors not encased on concrete shall be zinc plated steel as a minimum, in accordance with ASTM B-633. Withhold any zinc plating or galvanization in the weld region until after fabrication. Touch up of protective finishes following welding is necessary.

6. Acceptable manufacturers: Nelson Stud Welding, or Equal.

G. Anti-Galling Compound
   1. The anti-galling compound to be used on threads of stainless steel fastener assemblies in potable water systems shall be an ANSI/NSF 61-certified compound.
   2. Acceptable Products: Slic-Tite®, LA-CO Industries, Inc.; Real-Tuff™, Hercules Chemical Company, Inc.; or equal.

2.2 FABRICATION OF MISCELLANEOUS METALWORK

A. The Contractor shall take the necessary precautions, as described in ASTM A143 and ASTM A384, during fabrication of articles to be galvanized to properly fabricate and prepare the material to prevent embrittlement, warpage, and distortion.
   1. Steel tubing with cover plates welded at both ends or other enclosed assemblies shall have vent and drain holes drilled at locations shown on the assembly fabrication drawings approved by the Engineer. The holes shall be drilled during fabrication and before galvanizing.

B. Prior to beginning fabrication, the Contractor shall field-verify existing conditions and dimensions and shall be responsible for accuracy and layout of the work.

C. The Contractor shall review the drawings and the approved shop and erection drawings and shall report any discrepancies to the Engineer for clarification before starting fabrication.

D. After shop fabrication, stainless steel welds shall be cleaned, pickled, and passivated in accordance with ASTM A380. Contaminated surfaces shall be cleaned in accordance with ASTM A380 as approved by the Engineer.

E. Verify bolt hole and slot dimensions with the Structural Drawings prior to punching. Larger hole-diameters are required at connections like end-welded studs, some base plates, equipment skids, and at through-set undercut sleeve anchors.

2.3 FABRICATION – WELDING PROCESS RESTRICTIONS

A. SMAW welds will be permitted for manual welding.

B. In automatic welding, both the rate of travel and the rate of deposition of metal shall be controlled automatically.

C. Submerged arc welding (SAW) will be permitted for automatic or semi-automatic welding.

D. Gas metal-arc welding (GMAW) will be permitted for semi-automatic welding, short circuit transfer mode is not allowed.

E. Flux-core arc welding (FCAW) will be permitted only where specifically approved by the Engineer and provided that auxiliary gas shielding process is used.

2.4 FABRICATION – WELDING OF CARBON STEEL

A. Except for the modifications set forth in this section, the welding of miscellaneous metals or articles fabricated from carbon steel shall be in accordance with AWS D1.1.
   1. Electrodes for field welding shall not exceed 3/16 inch.
   2. Welding of pipe or tubing shall be in accordance with the recommendations of AWS D10.12.
   3. Runoff tabs shall be removed by hand flame-cutting or other means as close to the edge of the finished member as practical, followed by grinding to a smooth surface contiguous with the adjacent metal.

2.5 FABRICATION – WELDING OF STAINLESS STEEL

A. Welding of miscellaneous metal articles fabricated from stainless steel shall be in accordance with the following:
   1. Welding on austenitic stainless steel shall be performed by SMAW, GMAW, gas tungsten arc welding (GTAW), or FCAW process using direct current.
   2. Weld procedures shall be qualified in accordance with AWS B2.1.
      a. Interpass temperature shall not exceed 350°F.
   3. Welding of stainless pipe or tubing shall be in accordance with the recommended practices of AWS D10.4.
   4. Stainless steel to carbon steel welds will not require stress relieving heat treatment.
   5. Stress-relieving of austenitic stainless steel, where deemed necessary by the Engineer, shall be performed at 750°F for 4 hours, plus an additional 1/2 hour for each additional inch over 1/2 inch weld section thickness, or a full solution anneal at 1900°F shall be performed with rapid quench.
   6. Stainless steel welds shall be deburred and ground smooth using grinding wheels of aluminum oxide. Carborundum or other carbon bearing wheels are not acceptable for use on stainless steel surfaces. Wire brushing of stainless steel surfaces shall be performed only with stainless steel brushes. Grinding wheels and brushes used to clean stainless steel shall not have been used on carbon steel surfaces.

2.6 WELDING - ALUMINUM

A. Welding of aluminum shall be performed by GMAW or GTAW process using electrodes in accordance with AWS A5.10.

2.7 CARBON STEEL CHECKERED PLATE

A. Carbon steel floor plates shall be in accordance with ASTM A786 Pattern No. 4 or No. 5.

2.8 NOSING FOR CONCRETE STAIRS

A. Nosing for concrete stair treads and landings shall be an approved, flush mounted, non-slip, abrasive metal with hatched pattern finish having a 1/4-inch minimum nose depth. Nosing shall be 3 inches minimum width, of the length shown on the drawings, and shall be furnished in 1 piece. If the nosing length is not shown on the drawings, the nosing length shall be equal to the stair tread width less 3 inches each end. Nosing shall be drilled and countersunk for bolt-connection to the steps and landings.

B. Acceptable Products: CA-300, Balco USA, Inc.; Type 101, Wooster Products Inc.; or equal.

2.9 LADDERS

A. Fixed access ladders shall be in accordance with CCR Title 8, "General Industry Safety Orders, Ladders."

B. Ladders shall be made of carbon steel unless otherwise shown on the drawings.
   1. Ladders shall be fabricated with flat steel side rails and solid steel bar rungs. Side rails and rungs shall be smooth and free from burrs and sharp edges.
   2. Rungs shall be plug-welded into drilled holes in the side rails and seal-welded to the inside of the rail.
   3. Wall and floor brackets shall be welded to the side rails, and the joint shall be seal-welded on all planes.
   4. Carbon steel ladders shall be prepared and coated in accordance with the Architectural Drawings unless the ladder is for use inside a valve vault or manhole structure. Ladders used inside a valve vault or manhole structure shall be hot-dip galvanized after fabrication in accordance with ASTM A123.
   5. Fixed ladders 20 feet or greater in length shall be fabricated with cages designed per CCR Title 8 unless the ladder is for use in a vault or a manhole or is used infrequently or only in emergency.

C. Fall Prevention System
   1. Where indicated on the drawings or in the specifications, the Contractor shall equip each ladder with a complete rigid fall-prevention system.
   2. Ladders 20 feet or greater in height shall be equipped with a fall-prevention system, consisting of a fabricated ladder cage, except for ladders used in vaults, manholes or used infrequently or for emergency purposes. A fall prevention system may be substituted for a cage in the above cases.
   3. Under specific circumstances (exceptions defined in CCR Title 8 and in the preceding paragraph), a fall-prevention system may be substituted for a ladder cage. The fall prevention system shall meet or exceed the requirements of the Occupational Safety and Health Administration Regulation No. 1919.27. The system shall consist of stainless steel Type 316, fixed and notched rail, dismount section, mount section, rest piece, rung clamp assembly, removable extension kit, and cast manganese-bronze sleeve with cadmium-plated steel roller bearings and double-locking snap.

4. All fall-prevention system components shall come from the same manufacturer.
5. Acceptable Products: Saf T Climb®, North Safety Products, Ltd.; or equal.

2.10 SHOP FINISHES

A. Galvanizing
   1. Miscellaneous metal parts shall be galvanized when shown on the drawings.
   2. Galvanizing for shapes, plates, and fabricated items shall be in accordance with ASTM A123 with an average weight per square foot of 2.0 ounces and not less than 1.8 ounces per square foot.
   3. Bolts, anchor bolts, and other threaded fasteners required to be galvanized shall, after being properly cleaned, be coated in accordance with ASTM A153 Table 1.
   4. Except where otherwise specified, galvanizing shall be performed after fabrication, including cutting, punching, welding, and drilling.
   5. Prior to galvanizing, items shall be cleaned to meet SSPC SP-3.
      a. Weld flux, weld spatter, minor weld defects, paint, and grease shall be removed.
      b. Parts shall be alkaline cleaned and then acid pickled to remove mill scale and surface rust.
   6. Galvanizing shall be done after all fabrication is completed.
   7. Where galvanized light-gauge sheet goods are specified, upset edges of factory die punched holes need not have the bare edges re-galvanized and the galvanized coating adjacent to such die-punched edges need not be repaired.

B. Priming and painting: Miscellaneous metalwork shall be prepared, coated, and field repaired in accordance with the Architectural Drawings.
   1. Exterior miscellaneous steel and architecturally painted surfaces where designated shall be prepared and coated with painting systems noted on the Architectural Drawings.
   2. Interior miscellaneous steel not exposed to weather, nonvisible and covered by architectural finishes and not subject to view or specified to be painted shall be prepared and coated with 2-coats of zinc-rich epoxy primer, shop applied. Exposed portions of bolts and welds shall receive a minimum of 2-coats of zinc rich epoxy primer to match the coating of the structural steel.

C. Withhold primer and paint on portions of steel components intended to be in direct contact to newly placed concrete, unless corrosion-resistant coatings are specifically indicated on the Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation and anchorage details for items of miscellaneous metal, regardless of ultimate usage – ornamental, structural, architectural, mechanical, or electrical – shall be as shown on the drawings. Details not shown on the contract drawings shall be developed by the Contractor and indicated on the shop drawings.

B. Anti-galling compound shall be used each time stainless steel fasteners or combination stainless steel and silicon bronze fasteners are assembled or reassembled.

C. Embedded Items
   1. Unless otherwise specified or shown on the drawings, anchor bolts, embed plates, or straps, openings for pipes or conduits, and inserts for pipe hangers or other anchorages shall be installed prior to the placing of concrete. Items shall be accurately placed and securely held while concrete is being placed.
   2. Plates shall be bolted into their frames and the frame shall be incorporated within the concrete forms before concrete is placed.
   3. Pipe sleeves and blockouts shall be accurately placed and securely held to avoid movement or displacement while concrete is being placed.
   4. Openings formed in concrete for anchor bolts, the space beneath equipment base plates, and the space around gate frames shall be grouted in accordance with Section 03 60 00 after the equipment or structure has been accurately set in position and braced to prevent movement.

D. Anchor Bolts
   1. Anchor bolts shall be accurately set and maintained in position by templates while placing concrete.
   2. Anchor bolts shall be cleaned of dirt and other foreign substances prior to placing concrete. Tape or other protection shall be provided to prevent anchor bolt threads from being filled with concrete.
   3. Whenever it is impractical to place anchors or anchor bolts required for the installation of comparatively light metal accessories before the concrete is placed, concrete anchors shall be installed in accordance with Section 03 25 00.

E. Field-installed headed or threaded end-welded studs
   1. End-welded studs installed in the field shall be accurately set prior to fusion welding. Peen the installation location with an awl to maintain accurate stud layout.
   2. Protect adjacent materials, bolts, and finishes from weld flash, spark, etc.
   3. Follow the welding equipment, setting, surface preparation and cleaning, and installation requirements of the stud Manufacturer. Welding materials, procedure and welder certification shall be in accordance with AWD D1.1 Section 7 Stud Welding, the CBC, any applicable ICC-ES reports, and local jurisdictional requirements.

4. Clean the area of the weld with a wire brush to remove spatter. Touch up protective finishes in the vicinity of the weld as necessary.
5. Field testing of the fusion weld in conformance with Section 05 12 00, AWS D1.1, and the Drawings is required. In addition, prior to proceeding with cladding clip retrofit work, a minimum of five (5) pre-construction hammer-bending tests are required demonstrating no weld failure in the weld.
6. Verify that bolt holes and slots are capable of accommodating the flash diameter of the stud plus 1/16-inch, unless otherwise noted.
7. Connections of miscellaneous metals utilizing post-installed mechanical or adhesive concrete anchors shall be in conformance with Section 03 25 00.

3.2 REPAIR OF GALVANIZED SURFACES

A. Galvanized surfaces damaged during fabrication, shipping, erection, or at any time prior to acceptance of the work shall be prepared and recoated according to one of the following methods.
   1. The damaged components shall be thoroughly stripped and cleaned of all coating, and new galvanizing shall be applied by the hot-dipped process in accordance with ASTM A123 or ASTM A153 as applicable.
   2. The method of repair of damaged areas shall be as approved by the Engineer. Damaged areas shall be repaired by one of the methods listed below as specified in ASTM A780 with the following modifications:
      a. Repair surfaces shall be blasted clean to meet SSPC SP-5 or cleaned by mechanical means to meet SSPC SP-3 and coated immediately before any deterioration (flash-rust) occurs.
      b. Sprayed Zinc (Metallizing): 4.0 mils minimum thickness using a wire with at least 98 percent zinc.
      c. Zinc-Based Solders: 4.0 mils minimum thickness.
   3. Dry film thickness shall be verified using a magnetic-type gauge in accordance with ASTM D7091.
   4. The finished surface shall be of uniform texture, free of lumps, coarse areas, and loosely adhered areas.

3.3 FIELD PAINTING AND COATING

A. Miscellaneous metalwork that was not previously coated in the shop shall have the specified coating applied in the field in accordance with the Architectural Drawings.
   1. As a minimum, for interior structural steel, exposed portions of bolts and welds shall receive 2-coats of zinc rich epoxy primer to match the coating system of primered structural steel.

B. Field touch-up of shop painted or premiered components shall use a paint coating system in accordance with the Architectural Drawings, compatible with the shop finishes provided.

END OF SECTION

SECTION 05 50 10 – INTERIOR METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Shop-fabricated non-decorative metal items.
   2. Shop-applied primer.
   3. Delegated design of metal fabrications.
   4. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

1.2 REFERENCES

A. Abbreviations and Acronyms:
   1. AWS: American Welding Society.
   2. DFT: Dry Film Thickness.
   3. SSPC: The Society for Protective Coatings.

B. Definitions:
   1. Manufacturer: Means the grout or bituminous paint manufacturer, as the context admits, unless otherwise indicated.
   2. Fabricator: Means the metal fabricator, unless otherwise indicated.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Delegated Design Requirements:
   1. Engineer, fabricate, assemble, and install metal fabrications that conform to the profiles indicated and other Contract Document requirements; meets specified performance criteria; and results in structurally sound and non-corroding assemblies that accommodate, resist, distribute, or transfer in-service loads without incipient or catastrophic failure.
   2. Maintain visual design concept indicated, including sizes, profiles, and alignments. Deviation from visual design concept is non-conforming work and prohibited without prior written acceptance by the Architect.

B. Performance Requirements:
   1. Design Loads: Indicated on the Drawings.
   2. Deflection: Not more than 1/8-inch.

3. Thermal Expansion and Contraction: Accommodate movement resulting from at least 120 deg. F ambient and 180 deg. F material surface temperature differentials (changes).
4. Dissimilar Metal Corrosion Protection: Permanently isolate metal surfaces from direct contact with incompatible materials and other potentially corrosive substrates as specified below.

1.4 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data: For manufactured items, submit manufacturer's product data, specifications, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs) and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
   2. Shop Drawings:
      a. Submit dimensioned plans and elevations drawn to scale and showing metal fabrication layout and types. Show locations, sizes, and extents of all items, accessories, and trim. Label manufactured items by product name.
      b. Include project-specific dimensioned details drawn to scale showing profiles, shapes, joints, seams, and dimensions, including coves, miters, and corner conditions. Cross-reference details to plans and elevations.
      c. Indicate method of attaching, fastening, joining, adhering, and anchoring to adjacent construction.
      d. Show backings, embedments, fasteners, brackets, clips, cleats, straps, mounting devices, and other attachments.
      e. Label each attachment type; indicate manufacturer's product name for each manufactured item.
      f. Indicate base material and finish, fastener material and finish, and material and finish of items being fastened or attached.
      g. Label welds in conformance with the requirements of AWS publication A2.4, "*Standard Symbols for Welding, Brazing, and Nondestructive Examination*".

B. Informational Submittals: Submit the following for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
   1. Delegated Design Submittals: Together with shop drawings, submit engineering calculations demonstrating conformance to the Contract Documents and all impacts of delegated design scope of work on other work.
      a. Calculations must be explicit and legible and must incorporate distinct cross-references to submitted shop drawings in sufficient quantity to render the calculations readily intelligible and reviewable.
      b. At a minimum, calculations must include design loads; analysis of supporting construction, including section-property computations; analysis of fasteners,

anchors, attachments, and connectors; and signature and seal of the licensed professional engineer responsible for preparing them.

c. Test reports are not an acceptable substitute for calculations and are returned to the Contractor without review or responsive action, except to record non-conformance with this requirement.

2. Qualification Statements: Submit written descriptions confirming experience specified in QUALITY ASSURANCE article below.

1.5 QUALITY ASSURANCE

A. Quality Standard:

1. Design Standard for Galvanized Items: Items indicated as galvanized must be designed and fabricated in conformance with the requirements of AGA publication, "*The Design of Products to be Hot-Dip Galvanized after Fabrication"*, and ASTM A 385. Limit the use of vent and drain holes and locate where they drain by gravity and are concealed from view in the finish work.
2. Welding Standards: Welding procedures must conform to the requirements of the following American Welding Society publications.
   a. AWS D1.1, "*Structural Welding Code – Steel*".
   b. AWS D1.2, "*Structural Welding Code – Aluminum*".
   c. AWS D1.3, "*Structural Welding Code – Sheet Steel*".
   d. AWS D1.6, "*Structural Welding Code – Stainless Steel*".
   e. AWS D1.8, "*Seismic Supplement*".
   f. AWS D9.1, "*Sheet Metal Welding*".
   g. AWS D10.10, "*Heating Practices For Pipe And Tube*".
   h. AWS D10.11, "*Root Pass Welding For Pipe*".
   i. AWS D10.12, "*Pipe Welding – Mild Steel*".
   j. AWS D10.18, "*Pipe Welding – Stainless Steel*".
   k. AWS D11.2, "*Welding – Cast Iron*".
   l. AWS D18.2, "*Stainless Steel Tube Discoloration Guide*".
   m. AWS D19.0, "*Welding Zinc Coated Steel*".

B. Qualifications:

1. Fabricator: Company or individuals must have at least 10 years' experience fabricating metal fabrications installed on at least 100 previous projects similar to this project in size, material, design, and complexity
2. Installer: Company or individuals must have at least 5 years' experience installing metal fabrications for at least 30 previous projects similar to this project in size, material, design, and complexity.
3. Welders: Welding personnel and supervisors must comply with the "*Qualification*" requirements of AWS quality standard publications. Only certified welders current in their certification may perform or supervise any welding work.

4. Supervisors: Individuals must have at least 7 years' experience installing metal fabrications for at least 30 previous projects similar to this project in size, material, design, and complexity, including at least 2 years' supervisory experience directing and leading metal fabrication installers.
5. Engineer: Must be a licensed professional structural engineer registered to practice in California having at least 10 years' experience performing the kind of engineering services indicated for at least 20 previous projects similar to this project in size, material, design, and complexity.

1.6 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
   1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
   2. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items as shipped. Furnish adequate dunnage and bracing during storage.
   1. Prevent stored items from contacting the floor or ground, from soiling and staining, and from deterioration and damage.
   2. If items are not stored in an enclosed location, then cover the tops and sides with securely-tied, waterproof, and breathable covers. Unvented polyethylene tarpaulins do not qualify as breathable covers and are prohibited. (due to potential accumulation of moisture beneath tarpaulin during certain environmental conditions)
   3. Incline covered items to ensure maximum drainage of accumulated moisture.
   4. Do not leave items uncovered where they might be exposed to weather or become wet from rain, mist, relative humidity, condensation, frost, and other sources of moisture; or exposed to other sources of deterioration and damage.

C. Handling: Handle items in a manner that that prevents damage.

D. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective metal fabrications with undamaged new metal fabrications that do not exhibit deterioration, damage, or defects.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

PART 2 - PRODUCTS

2.1 IRON

A. Ductile Iron Castings: ASTM A 536, Grade 70-50-05 or better.

2.2 STEEL

A. Steel Plate: ASTM A 36 (mild steel).

B. Uncoated Steel Coil, Sheet, and Strip: Finished cold-rolled steel coil, sheet, and strip conforming to ASTM A 1008, CS Type B (commercial steel), unexposed (interior items) and exposed, temper rolled (exterior items), regular matte finish (40 to 59 AA), mill phosphatized.

C. HDG Metallic Coated Steel Coil, Sheet, and Strip: ASTM A 653, CS Type B (commercial steel), with equal coating weight on each surface, coating designation indicated below on both surfaces, minimized spangle, chemically treated, oiled, and mill phosphatized.
   1. Natural Finish: At least a G90 minimum coating designation (galvanized), minimized spangle, chemically treated, and oiled.
   2. Painted Finish: At least an A60 minimum coating designation (galvannealed), not chemically treated, not oiled, and mill phosphatized.

D. Hot-Rolled Steel Rods, Bars, and Shapes: ASTM A 36 (mild steel), merchant quality.

E. Steel Pipe: ASTM A 53, black pipe, Type and Grade as indicated below, size and weight class, schedule number, or outside diameter indicated and wall thickness as required by engineering calculations for type of use indicated.
   1. Type: Provide Type S (Seamless) pipe.
   2. Grade: Provide Grade A pipe for cold bending; otherwise provide Grade B pipe.

F. Steel Tubing:
   1. Steel Structural Tubing: ASTM A 500, Grade A, black, round or shaped hot-formed tubing as indicated, outside diameter or dimensions as indicated, and calculated wall thickness as required by engineering calculations for type of use indicated. Provide seamless tubing.
   2. Mechanical Tubing: ASTM A 513, black, Type 5 M.D. (mandrel drawn or Drawn over a Mandrel).

G. Steel Castings: ASTM A 27, Grade 65-35, Class 2 (post-weld heat-treatment not required).

H. Galvanized Carbon Steel Wire: Soft temper zinc-coated wire conforming to ASTM A 641, minimum Class 4 coating weight.

2.3 STAINLESS STEEL

A. Stainless Steel Bars, Hot-Rolled or Extruded Shapes: ASTM A 276, Condition T (hardened and tempered at a relatively high temperature), Type 304L (for welded applications) or Type 304 (for all other applications), passivated in conformance with ASTM A 967.

B. Stainless Steel Pipe: ASTM A 312, Grade TP (pipe), Type 304L (for welded applications) or Type 304 (for all other applications), passivated in conformance with ASTM A 967.

C. Stainless Steel Coil, Sheet, Strip, Plate, and Flat Bar:
   1. Exposed Locations: ASTM A 666 (annealed and tempered), Type 304L (for welded applications) or Type 304 (for all other applications), annealed, No. 4 (soft) temper (hardness not more than Rockwell B-65; can be bent flat upon itself in any direction), passivated in conformance with ASTM A 967.
      a. Uncoated (Bare) or Natural Finish: No. 2B (bright) finish.
      b. Painted Finish: No. 2D (matte) finish.
   2. Concealed Locations: ASTM A 240 (annealed) Type 304L (for welded applications) or Type 304 (for all other applications), No. 2D (matte) finish, annealed, No. 4 (soft) temper (hardness not more than Rockwell B-65; can be bent flat upon itself in any direction), passivated in conformance with ASTM A 967.

D. Stainless Steel Tubing: ASTM A 554, Grade MT (tubing), Type 304L (for welded applications) or Type 304 (for all other applications), No. 2D (matte) finish, passivated in conformance with ASTM A 967.

E. Stainless Steel Castings: ASTM A 743, Grade CF8M or CF3M.

2.4 ALUMINUM

A. General: Unless otherwise indicated, provide aluminum alloy and temper recommended by both the metal producer for the type of use, strength, and welding characteristics; and by the aluminum finisher for color match and compatibility of fabricated items with specified finish.

B. Cold-Rolled Aluminum Bar and Rod: ASTM B 211.

C. Extruded Bars, Shapes and Tubes:
   1. Standard Structural Profiles: ASTM B 308, Alloy 6061-T6.
   2. Extruded Aluminum Bars and Shapes: ASTM B 221.
      a. Alloy and Temper: 6063-T5 or T6 for primary components; 6063-T5 or T6, 6005-T5, 6105-T5 or 6061-T6 for structural components.
      b. Minimum Thickness: At least 0.125-inch.

D. Sheet and Plate: ASTM B 209.
   1. Alloy and Temper: 5005-H32 (for anodic finishing), or alloy 3003-H14 (for painted or unfinished sheet).
   2. Minimum Thickness: At least 0.060-inch.

E. Aluminum Pipe:
   1. Structural Aluminum Pipe and Round Tube: ASTM B 429.
   2. Seamless Aluminum Pipe and Seamless Extruded Tubes: ASTM B 241.

F. Aluminum Tubing:
   1. Seamless Drawn Aluminum Tubes: ASTM B 210.

2. Extruded Aluminum Tubes: ASTM B 221 or ASTM B 483.

G. Aluminum Die and Hand Forgings: ASTM B 247.

H. Aluminum Castings: ASTM B 26.

2.5 ACCESSORIES

A. Flanges and Anchors: Unless otherwise indicated, provide cast or formed metal of the same type, material, and finish as the supported metal fabrications.

B. Grout:
1. Description: Pre-packaged, non-shrink, non-metallic, non-corrosive, non-staining, non-gaseous grout conforming to ASTM C 1107, Grade A (drypack) and Grades B and C (flowable grout) of a consistency suitable for application within a 30-minute working time.
2. Type: Grout specifically recommended by the manufacturer for interior and exterior applications.
3. Minimum 28-day Compressive Strength: At least 7,500 pounds per square inch.

C. Other Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

2.6 SHOP APPLIED STEEL PRIMER

A. Surface Preparation: Prepare surfaces in conformance with manufacturer-prepared published and supplemental instructions, and SSPC surface preparation standard SSPC-SP3, "*Power Tool Cleaning*".

B. Acrylic Primer:
1. Description: Hydrophobic acrylic dry-fall high performance coating primer
2. Application: Applied to interior exposed-in-service steel surfaces.
3. Product: "Uni-Bond DF Series 115" manufactured by the Tnemec Co., or equal.
4. Requisite Properties:
a. Minimum Thickness: Between 2.0 and 3.5 mils DFT per coat, when measured in conformance with SSPC paint application standard SSPC-PA2, "*Measurement of Dry Coating Thickness with Magnetic Gages*".
b. Color: Match Tnemec color 10-1009, "Gray".
5. Performance Requirements:
a. Minimum Dry Film Adhesion: At least a 5B rating, when tested in conformance with ASTM D 3359.

b. Minimum Humidity Resistance: No blistering, cracking, rusting, or delaminating of film after at least 500 hours exposure, when tested in conformance with ASTM D 4585.
c. Minimum Salt Spray Resistance: No blistering, cracking, rusting, or delaminating of film and no rust creep at scribe after at least 500 hours exposure, when tested in conformance with ASTM B 117.
d. Minimum Slip Coefficient Rating: At least 0.50 (AISC Class B surface), when tested in conformance with ASTM A 490.

2.7 FABRICATION

A. Shop Fabrication:
1. Fabricate items in largest sections practicable to minimize field jointing.
2. Fabricate exposed work precise, straight, and true to line, size, and shape; plumb, level, and square within allowable tolerances; and with accurate angles and surfaces, and crisp straight edges.
3. Fabricate exposed connections with flush hairline joints, and square and true edges and corners.
4. Form bent metal corners to the smallest radius possible without causing grain separation or otherwise impairing the strength of the material.
5. Bend pipe without collapsing or deforming its walls, to produce a smooth, uniform curved section and to maintain uniform sectional shape.
6. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
7. Cut, reinforce, drill, punch, thread, and tap metal fabrications as necessary to receive other fabrications, components, accessories, hardware, and similar items, and as required to securely attach to supporting construction
8. Before cleaning, treating, and applying specified finishes, remove blemishes by grinding.
9. Remove sharp or rough areas on exposed traffic surfaces. Ease exposed edges to a nominal 1/32-inch radius.

B. Fabrication Tolerances: Fabricated items must conform to the following; specified tolerances are non-cumulative.
1. Squareness: Not more than 1/8-inch difference in diagonal measurements.
2. Maximum Offset between Components at Joints: 1/16-inch except that at welded joints, offsets are prohibited.
3. Maximum Misalignment of Adjacent Members: 1/16-inch.
4. Maximum Bow: 1/8-inch in 48 inches.
5. Maximum Deviation from Plane: 1/16-inch in 48 inches.

C. Shop Priming: :

1. Install primer using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
2. Only install primers under conditions that ensure finishes are free from blemishes and defects.
3. To avoid surface contaminant pick-up, promptly prime prepared surfaces as soon as practicable after and within the same day as surface preparation.
4. Verify primer film thickness during application by taking numerous measurements.
5. Provide smooth surfaces of uniform finish, color, appearance, and coverage. Primer surfaces with cloudiness, spotting, holidays, runs, or other imperfections are prohibited and are rejected as non-conforming work.
6. Do not exceed the application rates recommended by the manufacturer.
7. Installed primers must be warrantable. Do not install, correct, or replace primers in a manner that results in any warranty or guarantee becoming void.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification: Verify that in-place construction conforms to the manufacturer's requirements or recommendations and satisfies all other conditions that might affect the quality of installation or the durability, appearance, or performance of installed items.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the fabricator's instructions and other requirements and recommendations.
   2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 INSTALLATION

A. General Requirements:
   1. Scribe and cope items as necessary for an accurate fit. Perform required cutting, drilling, and fitting for metal fabrication installation.
   2. Set metal fabrications true to line, to required levels and lines, plumb, square, and cut and fitted without warp or rack; sloped or level as required; with flush well-fitted joints; and in alignment with adjacent construction.
   3. Shim as required with concealed shims.

4. Dry-pack metal fabrications supported on concrete and masonry to provide firm, level bearing surfaces.
5. Provide temporary bracing or anchors for items indicated as built into concrete, masonry, or similar construction.
6. Fit exposed connections accurately to form flush hairline joints

B. Interface with Adjacent Items:
1. Attachment: Provide materials, components, and accessories normally furnished or necessary to securely attach metal fabrications to supporting construction.
2. Field Welding:
a. Comply with AWS quality standard publications for manual shielded arc welding procedures, appearance and quality of welds, and methods to correct faulty welds.
b. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
c. Before welding, grind to remove zinc coating from one to 4 inches from either side of the intended weld zone and on both sides of the item.
d. Obtain fusion without undercut or overlap.
e. Promptly remove welding flux.
f. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
g. Do not weld, cut, or abrade exterior surfaces hot-dip galvanized after fabrication and are for bolted or screwed field connections.
h. Field-weld connections indicated as exposed joints but cannot be shop-welded because of shipping size limitations.
i. Welds remaining exposed must be ground smooth and flush to match and blend with parent metal surfaces.
j. Clean field welds, weld spatter, bolted connections, and abraded areas promptly after installation.

C. Installation Tolerances: Install metal fabrications to an allowable tolerance variation of not more than 1/4-inch from true position and not more than 1/8-inch and from plumb, level, and alignment.

3.3 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include

1. written descriptions of non-conforming, damaged, and defective work;
2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

D. Damaged Primer Touchup: Clean and prepare damaged primed surfaces in conformance with manufacturer's published instructions and SSPC surface preparation standard SSPC-SP11 "*Power Tool Cleaning to Bare Metal*".
   1. Sand smooth and re-clean.
   2. Spot-prime bare metal surfaces with specified primer applied to a total spot primer DFT of at least 5 mils.
   3. Overlap undamaged primer areas with spot primer at least 2 inches.

E. Damaged Galvanizing Touchup: Repair damaged galvanized items or re-galvanize items that cannot be satisfactorily repaired to the Architect's acceptance.
   1. Zinc-Based Solder Repair: Repair damaged galvanizing in conformance with ASTM A 780 Annex A1.
   2. Organic Zinc-Rich Cold Galvanizing Compound Repair:
      a. Repair damaged galvanizing in conformance with ASTM A 780 Annex A2
      b. Apply cold galvanizing repair compound to a DFT of 1.5 plus or minus 0.5 mils per coat, when measured in conformance with SSPC publication SSPC-PA 2, "*Determining Compliance to Required DFT*". Provide 2 coats.

3.4 CLEANING

A. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

END OF SECTION

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DIVISION 06

WOOD, PLASTICS, AND COMPOSITES

SECTION 06 10 53 – MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Utilitarian lumber and plywood not specified in other sections.
   2. Telephone and electrical equipment backing panels.
   3. Preservative treated wood.
   4. Fire-retardant treated wood.
   5. Rough hardware.
   6. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

1.2 REFERENCES

A. Abbreviations and Acronyms:
   1. ACQ: Alkaline Copper Quaternary.
   2. APA: Means the Engineered Wood Association.
   3. ASME: American Society of Mechanical Engineers.
   4. AWPA: American Wood Protection Association.
   5. CCA: Chromium Copper Arsenate.
   6. FRTW: Fire Retardant Treated Wood.
   7. PTW: Preservative Treated.
   8. S4S: Surfaced Four Sides.
   9. WCLIB: West Coast Lumber Inspection Bureau.

B. Definitions:
   1. Manufacturer: Means the plywood, PTW, FRTW, rough hardware, or accessory manufacturer, as the context admits, unless otherwise indicated.
   2. Pressure-Treated Wood: Means either PTW or FRTW.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Provide fasteners and accessories suitable for the type of use and conditions of installation and service; and as required to produce secure attachment to supporting construction without staining or deterioration of either base materials or

fastened materials; nor deterioration of the fastener itself when in contact with base materials and fastened materials.

1. Fastening Pressure-Treated Wood: Fasteners must resist corrosion when in contact with materials used in the pressure treating process that are either present at the time of installation or occur in the presence of moisture.
   a. Provide ceramic-coated anti-corrosive steel fasteners and hot-dip galvanized steel connectors conforming to ASTM A 653 Class G185 or provide Type 316 stainless steel fasteners and connectors.
   b. Fasteners and connectors made from uncoated (bare) carbon steel, electrodeposited zinc-coated steel, and aluminum are prohibited.
2. Other Exterior Locations: Provide ceramic-coated anti-corrosive steel fasteners or stainless steel fasteners.
3. Elsewhere: Fasteners may be coated or uncoated, as selected by the Contractor, unless otherwise indicated or specified.

1.4 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data: For manufactured items, submit manufacturer's product data, specifications, typical installation details, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs) and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
   2. Shop Drawings: Include project-specific dimensioned details drawn to scale showing rough carpentry attachment to supporting construction; and other conditions not detailed on the product data; or that are detailed, but not in a manner specific to the project.
   3. Samples: When requested by the Architect, submit full-size samples of selected metal fasteners.

B. Informational Submittals: Submit the following for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
   1. Manufacturer's Instructions: Submit manufacturer-prepared published instructions for proper installation of furnished rough carpentry.
      a. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.
      b. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.

1.5 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
   1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
   2. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items as shipped. Furnish adequate dunnage and bracing during storage.
   1. Prevent stored items from contacting the floor or ground, from soiling and staining, and from deterioration and damage.
   2. If items are not stored in an enclosed location, then cover the tops and sides with securely-tied, waterproof, and breathable covers. Unvented polyethylene tarpaulins do not qualify as breathable covers and are prohibited. (due to potential accumulation of moisture beneath tarpaulin during certain environmental conditions)
   3. Incline covered items to ensure maximum drainage of accumulated moisture.
   4. Do not leave items uncovered where they might be exposed to weather or become wet from rain, mist, relative humidity, condensation, frost, and other sources of moisture; or exposed to other sources of deterioration and damage, including heat and sudden changes in temperature.
   5. Do not leave items uncovered where they might be exposed to weather or become wet from rain, mist, relative humidity, condensation, frost, and other sources of moisture; or exposed to heat or sudden changes in temperature; or exposed to other sources of deterioration and damage.

C. Handling: Handle items in a manner that that prevents damage.

D. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective materials with undamaged new materials that do not exhibit deterioration, damage, or defects.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer: Provide lumber and plywood manufactured by one of the following, or equal.
   1. Boise Cascade LLC.
   2. Georgia-Pacific Wood Products LLC.
   3. Louisiana-Pacific Corp.

4. Weyerhaeuser NR Co.

2.2 SAWN LUMBER

A. Timber for Wood Beams, Stair Stringers, and Posts: “SELECT STRUCTURAL” grade Douglas fir conforming to WCLIB Grading Rules, S4S, seasoned to a moisture content of not more than 19 percent, and stamped showing only the appropriate fiber stress in bending “f”.

B. Rough Sawn Lumber: “#1” or “#2” grade Douglas conforming to WCLIB Grading Rules, rough sawn, dried to a moisture content of not more than 19 percent, and stamped “S-DRY” or “KD”.

C. Full-Dimension Lumber: “#1” or “#2” grade Douglas conforming to WCLIB Grading Rules, S4S, seasoned to a moisture content of not more than 19 percent, and stamped “S-DRY” or “KD”.

2.3 SOFTWOOD PLYWOOD

A. Softwood Plywood:
   1. Minimum Sheathing Grade: “APA C-C Plugged & Touch Sanded EXT” grade plywood, unless otherwise indicated. Plywood panels must have a visible APA grade mark.
   2. Minimum Underlayment Grade: “APA Tongue & Groove” grade plywood, unless otherwise indicated. Plywood panels must have a visible APA grade mark.
   3. Minimum Size: At least 4- by 8-foot nominal sheet size.
   4. Minimum Thickness: At least 1/2-inch nominal thickness, unless otherwise indicated.
   5. Construction:
      a. 3/4-inch plywood: 7-ply veneer core.
      b. 1/2-inch plywood: 5-ply veneer core.
   6. Panel Edges: Square-edged.

B. Telephone and Electrical Equipment Backing Panels:
   1. Minimum Grades: “APA Type A-D” grade sanded plywood. Plywood panels must have a visible APA grade mark.
   2. Minimum Thickness: At least 3/4-inch nominal thickness, unless otherwise indicated.
   3. Construction: 7-ply veneer core.
   4. Panel Edges: Square-edged.
   5. Finish: Field-applied intumescent white paint finish. Paint both sides of plywood to prevent warping.

2.4 PRESERVATIVE TREATED WOOD (PTW)

A. Description: Wood products conforming to the AWPA U1 manufactured with ACQ wood preservative. PTW containing arsenic or CCA are prohibited.
   1. Interior wood construction not in contact with the ground must conform to Use Category UC2.
   2. Exterior wood construction not in contact with the ground must conform to Use Category UC3b.
   3. Wood contacting the ground must conform to Use Category UC4a.

B. Application: Provide PTW at the following locations and where indicated.
   1. Concealed rough carpentry items in contact with concrete or masonry.
   2. Miscellaneous wood framing attached directly to the interior of below-grade exterior masonry or concrete walls.
   3. Rough carpentry in contact with roofing, metal flashings, vapor retarders or barriers, air barriers, or waterproofing.
   4. Wood framing members less than 18 inches above the ground in crawl spaces or unexcavated areas.
   5. Wood floor plates installed on concrete slabs-on-grade.
   6. Wood items exposed to weather.

C. Products: Provide the following manufactured by Sunbelt Forest Products Corp., or equal.
   1. Termite Resistant Wood: “Timbersave PT”, or equal.
   2. Decay and Termite Resistant Wood: “Preserve”, or equal.
   3. Decay, Termite, and Water Resistant Wood: “Preserve Plus”, or equal.

D. Requisite Properties:
   1. Minimum Retention: At least 0.25 pounds per cubic foot in conformance with AWPA C2 for lumber and timber and AWPA C9 for plywood.
   2. Maximum Moisture Content: Kiln dry after treatment to a moisture content of not more than 19 percent for lumber, and not more than 15 percent for plywood.

2.5 FIRE-RETARDANT TREATED WOOD (FRTW)

A. Description: Wood products conforming to AWPA C20 and AWPA C27, manufactured with fire-retardant materials for which the fire-retardant manufacturer publishes physical properties of treated wood after exposure to elevated temperatures, when tested in conformance with ASTM D 5664 and ASTM D 5516.
   1. Provide exterior type wood at exterior locations.
   2. Provide Type A High Temperature (HT) wood at interior locations.

B. Application: Provide FRTW at the following locations and elsewhere where indicated.

1. Framing for raised platforms.
2. Concealed blocking.
3. Roof construction.
4. Plywood backing panels.
5. Other wood items installed within fire-resistive construction.
6. Elsewhere where indicated.

C. Restrictions: Fire-retardant products must not develop or advance metal fastener corrosion.

D. Products: Provide the following manufactured by Hoover Treated Wood Products, Inc., or equal
1. Interior Locations: “Pyro-Guard”, or equal.
2. Exterior Locations: “Exterior Fire-X”, or equal.

2.6 ROUGH HARDWARE

A. Uncoated (Bare) Carbon Steel Fasteners:
1. Screws: Manufactured from carbon steel wire rods and uncoated coarse round wire conforming to ASTM A 510, Grades 1018 to 1022.
2. Bolts: ASTM A 307, Grade A.
3. Nuts and Flat Washers: ASTM A 563, Grade C3.

B. HDG Zinc-Coated Steel Fasteners:
1. Description: Carbon steel fasteners with hot dip galvanized coating conforming to
a. ASTM A 153 minimum zinc coating weight requirements for Class C materials (fasteners over 3/8-inch diameter and similar articles; washers 3/16-inch and 1/4-inch thick) or Class D materials (fasteners 3/8-inch diameter and under, rivets, nails and similar articles; washers under 3/16-inch thick); and
b. ASTM F 2329 for coating of threaded fasteners and washers by hot-dip zinc galvanizing.
2. Performance Requirements: No sign of surface red rust after at least 32 hours of ASTM B117 salt spray test performed on screws after being driven through and removed from sheet metal panels.

C. Stainless Steel Fasteners:
1. Description: Austenitic stainless-steel screws, bolts, and studs conforming to ASTM F 593 and nuts conforming to ASTM F 594 requirements for Alloy Group 1 (304 Series) or Alloy Group 2 (316 Series).
2. Performance Requirements:
a. Type 304: No sign of surface red rust after at least 1,000 hours of ASTM B117 salt spray test performed on screws after being driven through and removed from sheet metal panels.

b. Type 316: No sign of surface red rust after at least 1,500 hours of ASTM B117 salt spray test performed on screws after being driven through and removed from sheet metal panels.

D. Ceramic-Coated Anti-Corrosive Steel Fastener Material:
1. Description: Carbon steel fasteners having 3-coat finish that provides electrolytic corrosion protection by combining the sacrificial protection of zinc with the barrier protection of a ceramic topcoat and having a current evaluation report from the ICC-ES demonstrating code compliance.
2. Application: Use ceramic-coated anti-corrosive steel fasteners
a. with pressure treated wood, including alkaline copper quaternary (ACQ), ammoniacal copper arsenate (ACA), chromated copper arsenate (CCA), ammoniacal copper zinc arsenate (ACZA), copper azole (CBA-A and CA-B), copper citrate (CC), and disodium octaborate tetrahydrate (DOT);
b. when attaching to exotic hardwood lumber base material;
c. with composite lumber; and
d. when attaching cement board, high-density exterior sheathing, and tile backer board to framing members at exterior walls, at high-moisture interior walls, and in high-corrosion environments.
3. Product: “Grabber” screws manufactured by Grabber Construction Products, or equal.
4. Requisite Properties:
a. Basecoat An 8- to 10-micron (0.0003- to 0.0004-inch) mechanically deposited zinc-alloy coating.
b. Intermediate Coat: Chromate conversion coating.
c. Topcoat: Corrosion-resistant baked ceramic surface coating.
5. Performance Requirements: No sign of surface red rust after at least 1,000 hours of ASTM B 117 salt spray test performed on screws after being driven through and removed from sheet metal panels.

E. Nails, Brads, and Staples: Provide fasteners conforming to ASTM F 1667.
1. Fastening Lumber to Lumber: Cement-coated or annular (ringed-shank) threaded nails of sufficient length to penetrate at least1-1/4-inches into adjoining items; or stove or lag bolts used with washers.
2. Fastening Plywood to Lumber: Annular (ringed-shank) threaded nails; at least size 8d for 1/2-inch panels and at least size 10d for 3/4-inch panels.

F. Power-Driven Staples, Nails, P-nails, and Allied Fasteners: Must conform to ICC-ES Evaluation Report No. 1539.

G. Wood Screws: Must conform to ASME B18.6.1.

H. Steel Drill Screws for Fastening Wood to Cold-Formed Metal Framing: Must conform to ASTM C 954, except with wafer heads and reamer wings, length as recommended by the screw manufacturer for material being fastened.

I. Bolts:
   1. Steel Bolts: ASTM A 307 Grade A with hex nuts conforming to ASTM A 563, and flat washers where indicated.
   2. Anchor Bolts: ASTM F 1554 Grade 36. Provide hot-dip zinc-coated anchor bolts where item being fastened is galvanized.
   3. Lag Bolts: Must conform to ASME B18.2.1.

2.7 ACCESSORIES

A. Wood Glue:
   1. Description: Yellow aliphatic resin polyvinyl acetate (PVA) glue.
   2. Manufacturers: Provide products manufactured by one of the following, or equal.
      a. Elmer's Products Inc.
      b. Franklin International.
      c. Gorilla Glue, Inc.
   3. Products: Provide the following manufactured by Franklin International, or equal.
      a. Interior Grade Glue: "Titebond Original" , or equal.
      b. Exterior Grade Glue: "Titebond III Ultimate", or equal.
      c. Moulding and Trim Glue: "Titebond Quick & Thick Mutisurface Glue", or equal.

B. Construction Adhesive:
   1. Description: General purpose, indoor or outdoor, drillable, moisture resistant, sandable, heavy duty construction adhesive.
   2. Product: "Titebond PROvantage" manufactured by Franklin International, or equal.

C. Other Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification: Verify that in-place construction satisfies all other conditions that might affect the quality of installation or the durability, or performance of installed and adjacent items.

C. Evaluation and Assessment:
   1. Identify deficient and non-conforming project conditions.

2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 INSTALLATION

A. General Requirements:
   1. Scribe and cope items as necessary for an accurate fit. Perform required cutting, drilling, and fitting for rough carpentry installation.
   2. Set rough carpentry true to line, to required levels and lines, plumb, square, and cut and fitted without warp or rack; sloped or level as required; with flush well-fitted joints; and in alignment with adjacent construction.
   3. Shim as required with concealed shims.
   4. Fit exposed connections accurately to form flush hairline joints

B. Special Techniques:
   1. Sort and select lumber so natural characteristics do not interfere with installation or with fastening. Do not use materials with defects that interfere with function or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
   2. Provide blocking and framing normally furnished, indicated, or required to support facing materials, fixtures, specialty items, and trim.
   3. Provide metal clips for fastening gypsum board or lath at corners and intersections where blocking or framing does not provide a surface for fastening edges of panels. Do not space clips more than 16 inches on center.
   4. Install wood furring, sleeper, blocking, grounds, nailers, and other items where indicated or required for attaching other work.
   5. Make tight connections between members.
   6. Select fasteners of size that will not fully penetrate members where opposite side is exposed to view or will receive finish materials.
   7. Recess bolts and nuts flush with surfaces, unless otherwise indicated. Do not countersink nail heads, unless otherwise indicated.
   8. Install fasteners without splitting wood.

C. Interface with Adjacent Items: Provide materials, components, and accessories normally furnished or necessary to securely attach rough carpentry to supporting construction.

D. Installation Tolerances: Install rough carpentry within the following tolerance variations.
   1. Maximum Out of Plumb: Not more than 1/4-inch in 10 feet.
   2. Maximum Out of Plane: Not more than 1/8-inch.

3.3 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
   1. written descriptions of non-conforming, damaged, and defective work;
   2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
   3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.4 CLEANING

A. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

END OF SECTION

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SECTION 06 41 19 – PLASTIC LAMINATE-CLAD WOOD CASEWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Shop-fabricated wood cabinets and casegoods.
   2. Plastic laminate countertops.
   3. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

1.2 REFERENCES

A. Abbreviations and Acronyms:
   1. 2DL: 2D Laminate.
   2. 3DL: 3D Laminate.
   3. RTF: Rigid Thermoformable Foils.
   4. HPL: High-Pressure Laminate.
   5. HPDL: High-Pressure Decorative Laminate.
   6. TFL: Thermally-Fused Laminate.
   7. CPA: Composite Panel Association.
   8. MDF: Medium Density Fiberboard.
   9. NEMA: National Electrical Manufacturers Association.
   10. WI: Woodwork Institute.

B. Definitions:
   1. Manufacturer: Means plastic laminate, finish hardware, or accessory manufacturer, as the context admits, unless otherwise indicated.
   2. Fabricator: Means the casework fabricator, unless otherwise indicated.
   3. Self-Closing Hinge: Means a type of hinge that has a spring built into it so when a cabinet door starts to close, at some point the spring takes over and pulls the door closed with a tap.
   4. Soft Closing Hinge: Means a type of hinge that has hydraulics built into it so when a cabinet door starts to close, at some point the hydraulics take over and ease the door closed silently; the cabinet door appears to glide closed.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate casework finish hardware with adjacent door hardware finishes.
   2. Coordinate casework design with countertops. Provide reinforcement as required to support countertops and backing. Countertops must not deflect to the point of cracking when subjected to in-service loads.

B. Shelving Performance Requirements:
   1. Design Load: Shelving must support at least 50 pounds per square foot uniformly distributed load; not more than 200 pounds total load per shelf.
   2. Deflection: Limit deflection under maximum design load to L/144, except that all shelving in the same room, or space must have the same thickness where not concealed by doors. Minimum shelving thickness must be at least 3/4-inch.
   3. Permanent Deformation: No permanent deformation at maximum design load after 48 hours continuous loading.

C. Sequencing:
   1. Schedule casework deliveries to the project site only after the building is enclosed with a permanent enclosure; “wet work” within storage areas (including concrete, cast underlayment, mortaring, grouting, plastering, and gypsum board finishing) is complete and cured or dried to a condition of equilibrium; storage areas are broom- and vacuum-clean; and the HVAC system is activated, operating, and maintaining ambient conditions at occupancy levels.
   2. Install casework only after all other finishing operations are complete, especially overhead finishes.
   3. After casework installation, maintain ambient conditions within design range until Final Completion.

D. Scheduling:
   1. Acclimation: Allow sufficient time in the construction schedule to acclimate casework to specified ambient conditions for between 72 hours and 6 weeks before installation begins, or until moisture content is not more than 8 percent, when measured with a moisture meter at specified ambient conditions.

1.4 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data: For manufactured items, submit manufacturer’s product data, specifications, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs) and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
   2. Shop Drawings:

a. Submit dimensioned plans and elevations drawn to scale and showing casework layout and types. Show locations, sizes, and extents of all casework, accessories, and trim. Label manufactured items by product name.
b. Include project-specific dimensioned details drawn to scale showing profiles, shapes, joints, seams, and dimensions, including coves, miters, and corner conditions specific to the project. Cross-reference details to plans and elevations.
c. Indicate method of attaching, fastening, joining, adhering, and anchoring to adjacent construction.

3. Samples: Submit at least one 8-inch square representative fabrication sample for each casework type, color, finish, and variety, including core panels, facings, and edgings.

B. Informational Submittals: Submit written descriptions confirming experience specified in QUALITY ASSURANCE article below for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).

1.5 QUALITY ASSURANCE

A. Regulatory Requirements: Operable parts for accessible casework must conform to the requirements of CBC Section 11B-309.

B. Quality Standards:
1. Woodworking Standard: Provide casework conforming to Architectural Woodwork Institute/Architectural Woodwork Manufacturer's Association of Canada/ Woodwork Institute publication "*Architectural Woodwork Standards*" requirements for each specified Grade.

C. Qualifications:
1. Woodworkers and Finishers: Company or individuals must have at least 10 years' experience fabricating casework installed on at least 100 previous projects similar to this project in size, material, design, and complexity.
2. Installer: Company or individuals must have at least 5 years' experience installing casework for at least 30 previous projects similar to this project in size, material, design, and complexity.
3. Supervisors: Individuals must have at least 7 years' experience installing casework for at least 30 previous projects similar to this project in size, material, design, and complexity, including at least 2 years' supervisory experience directing and leading casework installers.

1.6 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.

2. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items indoors as shipped, upright in their original packaging or containers, within dry, well-ventilated, broom-cleaned and enclosed storage areas.
   1. Furnish adequate dunnage and bracing during storage.
   2. Prevent stored items from contacting the floor, from soiling and staining, and from deterioration and damage.
   3. Do not leave items uncovered where they might become wet; or exposed to heat or sudden changes in temperature or relative humidity; or other sources of deterioration and damage, including dust and other airborne contaminants.

C. Handling: Handle items in a manner that that prevents damage.

D. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective casework with undamaged casework that does not exhibit deterioration, damage, or defects.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

PART 2 - PRODUCTS

2.1 ARCHITECTURAL WOOD CASEWORK

A. Cabinets and Casegoods: Faced panel casework conforming to the referenced woodworking quality standard, Section 10 requirements for Custom Grade, Construction Type A (frameless) single-length cabinet sections with Interface Style 1 (flush overlay) cabinet doors and drawers.

2.2 SOFTWOOD LUMBER

A. Description: FSC-Certified dressed lumber, surface four sides (S4S) smooth without knife marks, unless otherwise indicated.

B. Requisite Properties:
   1. Species: Douglas fir.
   2. Appearance Grade: Grade B & Better.

2.3 FACED PANEL CONSTRUCTION

A. Plastic Laminate Facing and Edgebanding:
   1. Description: High-pressure decorative laminate (HPDL) conforming to NEMA LD-3.
      a. Exposed Surfaces: General purpose type HPDL Grade HGS. Toe bases are exposed surfaces, unless indicated as receiving an applied base. (e.g., a resilient base)

b. Semi-Exposed Surfaces: Cabinet liner type HPDL, Grade CLS.
c. Concealed Surfaces: Backer type HPDL, Grade BKV.

2. Standard Laminate Manufacturers: Provide products manufactured by one of the following, or equal.
   a. Lamin-Art, Inc.
   b. Formica Corp.
   c. Panolam Industries International, Inc.
   d. Wilsonart LLC.
3. Requisite.
   a. Color: Indicated on the Drawings or equal.
   b. Pattern: Indicated on the Drawings or equal.
   c. Finish: Indicated on the Drawings or equal.

B. Countertop Substrate Panels:
1. Description: Moisture-resistant composite fiber panels conforming to ANSI A208.2 and made from 100-percent post-industrial recycled wood fiber and having no added urea-formaldehyde resin.
2. Restrictions: Plywood, other than marine-grade plywood, is prohibited.
3. Products: “Medex” manufactured by Roseburg Forest Products Co., or equal.
4. Requisite Properties:
   a. Minimum Density: At least 50 pounds per cubic foot.
   b. Minimum Grade: At least Grade 150-MR 50.

C. Other Substrate Panels:
1. Description: Flame retardant composite fiber panels conforming to ANSI A208.2 and made from 100-percent post-industrial recycled wood fiber and having no added urea-formaldehyde resin.
2. Restrictions:
   a. Plywood is prohibited for doors and drawers.
   b. When accepted in writing by the Architect, plywood may be used for casework boxes. (accepted by WI, though not recommended)
3. Products: “Medite FR” manufactured by Roseburg Forest Products Co., or equal.
4. Requisite Properties:
   a. Minimum Density: At least 50 pounds per cubic foot.
   b. Nominal Thickness: At least 1/2-inch, unless otherwise indicated.
   c. Minimum Grade: Grade 150.

2.4 FINISH HARDWARE

A. General:
1. Provide all hardware indicated, specified, and necessary for a complete installation.

2. Hardware finish must match the door hardware specified in Section 08 71 00, unless otherwise noted.

B. Manufacturers: Provide products manufactured by one of the following, or equal.
   1. Accuride.
   2. Blum, Inc.
   3. Doug Mockett & Co., Inc.
   4. Häfele America Co.
   5. Sugastune Corp.

C. Pulls:
   1. Description: Back-mounted pulls conforming to BHMA A156.9 Hardware Type No. A09021.
   2. Products: “DP128 Series” pulls manufactured by Doug Mockett & Co., Inc., or equal.
   3. Requisite Properties:
      a. Size: 4 inch.
      b. Finish: Satin Stainless Steel.

D. Hinges:
   1. Description: Frameless concealed hinges (European cup style) conforming to BHMA A156.9, B01601 with integrated soft-close mechanism in the hinge cup. Spring-type self-closing hinges are prohibited.
   2. Product: “Salice Silentia Series” manufactured by Häfele America Co., or equal.
   3. Requisite Properties:
      a. Provide hinges with between 95 and 100 degrees of opening for cabinets having retractable doors; and for cabinets next to walls or similar obstructions.
      b. Provide hinges with between 100 and 120 degrees of opening for cabinets requiring additional cabinet access.
      c. Provide hinges with between 165 and 175 degrees of opening for cabinets requiring the most cabinet access; and for installations where there are drawer pullouts in the cabinets.
      d. Provide at least 3 hinges for doors at least 24 inches wide or at least 36 inches high.
      e. Provide either screw- or rapido-mounted hinges.

E. Full Extension Drawer Slides:
   1. Description: Heavy Duty full extension slides conforming to BHMA A156.9 Hardware Type No. B05091, with decelerated closing
   2. Products: Provide the following supplied by Häfele America Co., or equal.
      a. Heavy Duty Side Mount Slides: “Accuride 3657” slides, or equal.
      b. Heavy Duty S Bottom Mount Slides: “Accuride 9307” slides, or equal.
   3. Grades:

a. Heavy Duty Slides: BHMA-certified Grade 1HD-200, rated to at least 200 pounds per pair for lateral file drawers greater than 24 inches wide.

4. Mounting Style:
   a. Provide side-mount slides for cabinet trays and drawers.
   b. Provide bottom-mount slides for cabinet pullouts and heavy duty storage platforms.
5. Finish: Indicated on the Drawings or selected by the Architect.
6. Accessories: Provide stops to prevent accidental removal.

F. Shelf Brackets:
   1. Description: Spoon-shaped 1/4-inch nickel-plated steel shelf supports.
   2. Product: “Item No. 282.04.739” manufactured by Häfele America Co., or equal.

G. Locks:
   1. Description: Cylinder locks that separate the lock core from the cylinder housing, allowing any combination of locking systems.
   2. Product: “Cylinder Module System” manufactured by Häfele America Co., or equal.
   3. Requisite Properties:
      a. All cabinet doors and drawers must be lockable.
      b. Certain areas may be keyed separate. Everywhere else must be keyed the same.
      c. Provide master keying.

H. Grommets:
   1. No Gap Small Grommets: “BRV1 Brava Grommet – Small”, or equal (fits a 2-3/8-inch hole size).
   2. Finish: Satin Chrome.

2.5 ACCESSORIES

A. Counter Supports:
   1. Description: Manufactured counter support brackets.
   2. Product: “Rakks EH Series - Counter Support Brackets” manufactured by Rangine Corp., or equal.
   3. Requisite Properties:
      a. Models: “EH-1818FM”
      b. Mounting Configuration: Indicated on the Drawings.
      c. Minimum Sizes: Indicated on the Drawings.
      d. Surface Mount Configuration: At least 450 pounds.
      e. Flush Mount Configuration: At least 300 pounds.
      f. Standard Finish: Shop primed for a field-applied finish.
      g. Custom Finish: Custom powder coat finish matching the Architect’s design reference (target) sample.

B. Wood Glue:
   1. Description: Yellow aliphatic resin polyvinyl acetate (PVA) glue.
   2. Manufacturers: Provide products manufactured by one of the following, or equal.
      a. Elmer's Products Inc.
      b. Franklin International.
      c. Gorilla Glue, Inc.
   3. Products: Provide the following manufactured by Franklin International, or equal.
      a. Interior Grade Glue: "Titebond Original", or equal.
      b. Exterior Grade Glue: "Titebond III Ultimate", or equal.
      c. Moulding and Trim Glue: "Titebond Quick & Thick Mutisurface Glue", or equal.

C. Construction Adhesive:
   1. Description: General purpose, indoor or outdoor, drillable, moisture resistant, sandable, heavy duty construction adhesive.
   2. Product: "Titebond PROvantage" manufactured by Franklin International, or equal.

D. Finishing Nails:
   1. Description: 15-gage finish nails.
   2. Manufacturers: Provide products manufactured by one of the following, or equal.
      a. DEWALT.
      b. PORTER-CABLE.
      c. SENCO.
   3. Requisite Properties:
      a. Point Style: Chisel or diamond point.
      b. Head Style: Brad.
      c. Interior Application Finish: Electro-galvanized.
      d. Exterior Application Finish: Stainless steel.
      e. Coating: Sencote.

E. Fastenings: Provide backings, inserts, loose connection hardware, fasteners, anchors, attachments, connectors, and other items supplied, required, recommended, or accepted by the fabricator for actual in-service conditions applicable to the project.

F. Other Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

2.6 FABRICATION

A. Fabricate items to the dimensions, profiles, and details shown, and in conformance with the specified quality standards requirements, unless otherwise noted or indicated.
   1. Shop-assemble work in as large units as practicable to minimize field cutting and jointing.

2. Where necessary to fit at the project site, allow ample allowance for cutting and fitting. Create sufficient scribe where items intersect walls and partitions.
3. Conceal means of fastening various items together.
4. Assemblies must be free from open joints, hammer and machine marks, structural defects, and surface blemishes.

B. Finish Hardware:
1. Accurately fit hardware and install in conformance with the manufacturer's instructions.
2. Accurately fit doors and drawers with uniform clearance at all edges.
3. Doors and drawers must operate freely, but not loosely, without sticking or binding, with all hardware adjusted and functioning properly.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification: Verify that in-place construction satisfies all other conditions that might affect the quality of installation or the durability, appearance, or performance of installed and adjacent items.

C. Evaluation and Assessment:
1. Identify deficient and non-conforming project conditions.
2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 INSTALLATION

A. General Requirements:
1. Scribe and cope items as necessary for an accurate fit. Perform required cutting, drilling, and fitting for casework installation.
2. Set casework true to line, to required levels and lines, plumb, square, and cut and fitted without warp or rack; sloped or level as required; with flush well-fitted joints; and in alignment with adjacent construction.
3. Shim as required with concealed shims.
4. Fit exposed connections accurately to form flush hairline joints

B. Special Techniques:

1. Install casework in a manner consistent with the specified grade; and plumb, level, true, and straight with no distortions.
2. Shim using concealed shims.
3. Secure to ground, stripping, and blocking with countersunk, concealed fasteners and blind nailing as required for a satisfactory installation.
4. At gypsum board construction, anchor through wall surface to wood blocking or wood studs only.
5. Furnish fillers, closures and trim as required for a complete installation. Scribe in place where required.

C. Interface with Adjacent Items:
1. Provide materials, components, and accessories normally furnished or necessary to securely attach casework to supporting construction.
2. Casework taller than 42 inches must be seismically anchored.

D. Installation Tolerances: Install casework to an allowable tolerance variation of not more than 1/4-inch from true position and not more than 1/8-inch and from plumb, level, and alignment.

3.3 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
1. written descriptions of non-conforming, damaged, and defective work;
2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.4 ADJUSTING

A. Verify smooth and quiet door, drawer, and finish hardware operation.

B. Lubricate and adjust operating parts and finish hardware to function properly, free from warp, twist, binding, and distortion. Confirm latches and locks engage securely without forcing or binding.

C. Rehang or replace doors, drawers, and finish hardware that do not operate freely in a safe and reliable manner.

3.5 CLEANING

A. Cleaning Work: Remove from exposed casework surfaces anything that might interfere with uniform oxidation or weathering. Clean all visible casework surfaces in a manner that does not result in any warranty or guarantee becoming void.
   1. Use cleaning materials, equipment, and accessories supplied, and means, methods, techniques, and procedures required, recommended, or accepted by the manufacturer.
   2. Do not use cleaning materials or procedures known to change, or that might change, the appearance of exposed finishes or adjacent surfaces; or cause deterioration or damage to exposed finishes or adjacent surfaces.
   3. Protect adjacent surfaces not being cleaned from staining, deterioration, damage, or other detrimental effects caused by cleaning.
   4. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be cleaned to the Architect's acceptance.

B. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

3.6 PROTECTION

A. Protect installed casework in place from soiling, deterioration, and damage until Substantial Completion.

B. Do not store anything in, on, adjacent to, or against installed casework unless it is protected from damage. Do not use installed casework as work surfaces.

C. Remove protection when it's no longer needed and before Substantial Completion.

END OF SECTION

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DIVISION 07

THERMAL AND MOISTURE PROTECTION

SECTION 07 01 56 – MEMBRANE ROOFING MODIFICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Patching existing low-slope membrane roofing systems, including around mechanical equipment pads, abandoned openings, new penetrations through existing roof coverings, and other locations.
   2. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications, including insulation roofing underlayment, insulation, roof cover board, flashings, and similar items.

1.2 REFERENCES

A. Definitions:
   1. Manufacturer: Means the roofing membrane manufacturer, unless otherwise indicated.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Existing Warranty Coordination: Do not patch, correct, repair, or replace roofing in a manner that results in any existing roofing system warranty or guarantee becoming void
   1. Notify warrantors and guarantors before starting work.
   2. Notify warrantors and guarantors upon completion, and obtain documentation verifying existing roofing system was inspected and original warranties and guarantees remain in effect.

1.4 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data: Submit manufacturer’s product data, specifications, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs) and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
   2. Shop Drawings:
      a. Include project-specific dimensioned details drawn to scale showing conditions not detailed on the product data; or that are detailed, but not in a manner specific to the project.

b. Include details of construction at penetrations, terminations, flashings, drains, and tie-ins to existing roofing.

B. Informational Submittals: Submit the following for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
1. Manufacturer's Instructions: Submit manufacturer-prepared published instructions for proper installation of furnished roofing.
a. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.
b. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.
2. Qualification Statements: Submit written descriptions confirming experience specified in QUALITY ASSURANCE article below.

C. Closeout Submittals: Submit the following to the Architect as a condition of project closeout.
1. Warranty Documentation: Submit final warranties signed by the manufacturer's representative with complete terms indicated for all warranties covering items furnished or installed under this specification section.

1.5 QUALITY ASSURANCE

A. Qualifications:
1. Installer: Company or individuals must have at least 5 years' experience installing roofing for at least 30 previous projects similar to this project in size, material, design, and complexity.
2. Supervisors: Individuals must have at least 7 years' experience installing roofing for at least 30 previous projects similar to this project in size, material, design, and complexity, including at least 2 years' supervisory experience directing and leading roofing membrane installers.

1.6 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
2. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items as shipped and in conformance with manufacturer's instructions and other requirements and recommendations for storage. Furnish adequate dunnage during storage.
1. Prevent stored items from contacting the floor or ground and from deterioration and damage.

2. If items are not stored in an enclosed location, then cover the tops and sides with securely-tied, waterproof, and breathable covers. Unvented polyethylene tarpaulins do not qualify as breathable covers and are prohibited. (due to potential accumulation of moisture beneath tarpaulin during certain environmental conditions)
3. Incline covered items to ensure maximum drainage of accumulated moisture.
4. Sheet products must be tightly rolled face out on a sturdy core designed for that purpose and vertically stored unless otherwise required or recommended by the manufacturer
5. Promptly remove and replace rolled sheet products that are flattened or distorted during shipping, unloading, or storage.
6. Do not leave items uncovered where they might be exposed to weather or become wet from rain, mist, relative humidity, condensation, frost, and other sources of moisture; or exposed to other sources of deterioration and damage, including heat and sudden changes in temperature, and UV exposure beyond manufacturer-recommended limits.

C. Handling: Handle items in conformance with manufacturer's instructions and other requirements and recommendations, and in a manner that that prevents damage.
1. Avoid damage to packaging and containers, and contamination of contents.
2. Rotate inventory; do not use items the shelf life of which is expired.

D. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective roofing materials with undamaged new roofing materials that do not exhibit deterioration, damage, or defects.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

1.7 PROJECT CONDITIONS

A. Ambient Conditions: Install roofing only when ambient temperature, RH, and other environmental conditions fall within ranges required, recommended, or accepted by the manufacturer.
1. Do not remove existing roofing components or install roofing during rain or snow, fog or mist; or when rain or snow is predicted within 24 hours of installation.
2. Proceed only when there is no threat of impending precipitation, and both current and forecasted weather conditions conform to those required, recommended, or accepted by the manufacturer.
3. Remove or install only as much roofing as can be made weathertight each day, including all flashing and detail work. Apply uninterrupted waterstops at the end of each day's work, and completely remove them before proceeding with the next day's work.

B. Existing Conditions: Surfaces receiving roofing must be dry. Install roofing only when substrate moisture content and surface temperature fall within ranges required, recommended, or accepted by the manufacturer.

C. Other Conditions: Do not apply roofing where dust is generated, or liquids are sprayed.

1.8 WARRANTY

A. Manufacturer Warranty: Furnish to the Owner a written manufacturer warranty for products, components, and accessories against all patent and latent defects, and incipient and catastrophic failure for 20 years.

B. Installer Guarantee: Furnish to the Owner a written guarantee for the work of this specification section against all defects in materials and workmanship for 5 years from date of acceptance. Guarantees must be properly prepared and signed on the guarantee form in Division 01.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Roofing Repair Materials:
   1. Provide materials furnished, required, recommended, or accepted by the existing roofing membrane manufacturer for the intended use; and compatible with components and accessories of the existing and new membrane roofing; and with existing substrates.
   2. Provide separation materials required to eliminate contact between incompatible materials.

B. Temporary Roofing Materials: Selection of materials and design of temporary roofing is Contractor's responsibility. Provide weights to retain temporary roof sheet materials in position.

2.2 ACCESSORIES

A. General: Provide new components and accessories necessary to accommodate roof-mounted equipment removal or relocation, penetrations, and addition new construction.

B. Sheet Metal Flashing: Provide sheet metal flashing furnished, required, recommended, or accepted by the original roofing membrane manufacturer.

C. Pipe Penetrations: Use flashing materials and techniques as recommended by NRCA utilizing portals mounted to curbs.

D. Other Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification:
   1. Verify in-place construction, project conditions, and the work of other specification sections conform to the manufacturer's instructions and other requirements and recommendations.
   2. Verify substrates are dry and free of deleterious and other substances that might interfere with roofing adhesion or performance.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.
   2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 PREPARATION

A. Protection:
   1. Work Area Protection: Protect work areas from damage during surface preparation and roofing installation.
   2. Adjacent Material Protection: Protect adjacent surfaces against soiling and damage. Utilize drop cloths, shields, masking, barricades, and other items necessary to protect adjacent surfaces.
   3. Opening Protection: Close and protect drains and other openings and penetrations to prevent roofing membrane adhesive intrusion or migration of liquids.

B. Substrate Preparation: Prepare substrates as required, recommended, or accepted by the manufacturer without limitation; and in a manner that does not result in any warranty or guarantee becoming void.

3.3 INSTALLATION

A. General Requirements:

1. Install roofing using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
2. Only install roofing under conditions that ensure finishes are free from defects.
3. Installed roofing must be warrantable. Do not install, correct, or replace roofing in a manner that results in any warranty or guarantee becoming void.

B. Flashing And Repair Work: Perform work in conformance with instructions and recommendations of the original installation material manufacturer.
1. Cut holes for penetrations.
2. Lay base flashing and seal down to membrane and penetration.
3. Strip in flashing with one layer of sheet material on single ply systems.
4. Counterflash as required to make watertight.

3.4 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
1. written descriptions of non-conforming, damaged, and defective work;
2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.5 CLEANING

A. Cleaning Work: Clean spills, stains, soiling, overspray, and fallout from adjacent surfaces.
1. Use cleaning materials, equipment, and accessories supplied, and means, methods, techniques, and procedures required, recommended, or accepted by the manufacturer.
2. Do not use cleaning materials or procedures known to change, or that might change, the appearance of exposed finishes or adjacent surfaces; or cause deterioration or damage to exposed finishes or adjacent surfaces.
3. Protect adjacent surfaces not being cleaned from staining, deterioration, damage, or other detrimental effects caused by cleaning.

4. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be cleaned to the Architect's acceptance.

B. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

3.6 PROTECTION

A. Protect roofing in place from deterioration, and damage until Substantial Completion.

B. Do not store anything on, adjacent to, or against roofing unless it is are protected from damage, as accepted in writing by the manufacturer's representative. Do not use installed roofing as work surfaces.

END OF SECTION

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SECTION 07 41 13 – METAL ROOF PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Roof panels.
   2. Delegated design of roof panel system.
   3. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

1.2 REFERENCES

A. Definitions:
   1. Manufacturer: Means the roof panel manufacturer, unless otherwise indicated.
   2. Failure: Includes noise or vibration caused by movement, material deterioration beyond normal weathering, and water leakage through roof panel and framing areas.
   3. Water Leakage: Means penetration of water onto the exposed inside surface of the test specimen under specified conditions of air pressure difference across the specimen during a 15-min test period. Water penetration at or around end dams or side rails is not leakage; end dams and side rails are installed to cause and control ponding over the panels and to support the panels. They are not part of the roof.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate building opening tolerances with roof panel manufacturing and erection tolerances. The manufacturer must accommodate building frame tolerances.

B. Delegated Design Requirements:
   1. Engineer, fabricate, assemble, and install roof panels that conform to the profiles indicated and other Contract Document requirements; meet specified performance criteria; and result in structurally sound, non-corroding, and weathertight assemblies that accommodate, resist, distribute, or transfer in-service loads without incipient or catastrophic failure.
   2. Maintain visual design concept indicated, including sizes, profiles, and alignments. Deviation from visual design concept is non-conforming work and prohibited without prior written acceptance by the Architect.

3. Panel structural properties must be determined in conformance with Aluminum Association publication "*Aluminum Design Manual- Specifications and Guidelines for Aluminum Structures*".
4. Roof panels must be tested to verify load capacity in conformance with ASTM E 72 "*Standard Test Method of Conducting Strength Tests of Panels for Building Construction*" for determination of negative (suction) load capacity.

C. Performance Requirements:
1. Design Pressure: Calculate in conformance with American Society of Civil Engineers/ Structural Engineering Institute publication ASCE/SEI 7, "*Minimum Design Loads and Associated Criteria for Buildings and other Structures*".
2. Design Wind Rating: Roof panel assemblies must conform to UL 580 Class 90 wind uplift requirements.
3. Clip and Panel Performance: Clip and panel components must resist design pressures, when panel bending and clip-to-panel strength are tested in conformance with ASTM E 1592.
4. Panel Deflection: Individual roofing panels may not deflect more than L/180 measured normal to the panel plane, when tested in conformance with ASTM E 1592.
5. Permanent Deformation: Individual roofing panels may not deform, buckle, or exhibit side lap separation when subjected to a 300-pound concentrated load applied to a 4-square-inch area located between supports at panel mid-span and center.
6. Air Leakage (AL): Maximum permanent AL rating of not more than 0.006 cubic feet per minute per square foot, when tested in conformance with ASTM E 1680 at 1.57 pounds per square foot minimum differential static air pressure in sequence with or before water leakage testing.
7. Water Leakage: No water leakage through the assembly or joints, when tested in conformance with ASTM E 1646 at the following differential pressures.
   a. Less than or Equal to 30 Degrees from Horizontal: 2.86 pounds per square foot minimum differential pressure.
   b. Steeper than 30 Degrees from Horizontal: 20 percent of the positive design wind pressure but not less than 6.24 nor more than 12 pounds per square foot minimum differential pressure.
8. Hydrostatic Head Resistance: No water leakage, when tested in conformance with both ASTM E 2140.
9. Solar Energy Performance Requirements:
   a. Minimum Solar Reflectance Index (SRI) Value: At least SRI 0.75 for low-slope roofs (less than 2:12 slope) and 0.16 for steep slope roofs (greater than or equal to 2:12 slope), when measured in compliance with ASTM E 1918.
   b. Minimum Aged Reflectance Value: At least 0.63 for low-slope roofs (less than 2:12 slope) and 0.20 for steep slope roofs (greater than or equal to 2:12 slope), when maintained under normal conditions and measured in conformance with ASTM E 1918.
   c. Minimum Emittance Value: At least 0.75, when measured in conformance with ASTM C 1371.

10. Thermal Expansion and Contraction: Accommodate movement resulting from at least 120 deg. F ambient and 180 deg. F material surface temperature differentials (changes).
11. Dissimilar Metal Corrosion Protection: Permanently isolate metal surfaces from direct contact with incompatible materials and other potentially corrosive substrates as specified in Section 05 50 00.

D. Preinstallation Meeting:
   1. Hold a meeting after submittal approval and at least 10 business days before beginning installation.
   2. During the meeting, review the Contract Documents, submittals, project conditions, and installation sequence and methods, including special details and conditions that might affect installation
   3. Identify and discuss adverse or unfavorable conditions detrimental to protecting stored materials or to installation; or to the quality, durability, appearance, or performance of installed roof panels. Resolve each condition.
   4. Finalize construction schedule.
   5. Record significant discussions and distribute meeting minutes. Do not begin installation until disagreements are successfully resolved to the satisfaction of all parties.

1.4 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data:
      a. Submit manufacturer's product data, specifications, typical installation details, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs) and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
      b. Submit sample warranties with warranty periods, terms, conditions, exclusions, and remedies explicitly defined for each warranty, including clear warranty period start dates. (e.g., date of manufacture, purchase, installation, Beneficial Occupancy, Substantial Completion, Final Completion, etc.)
   2. Shop Drawings:
      a. Submit dimensioned plans and elevations drawn to scale and showing roof panel layout, materials, construction, and finishes. Show locations, sizes, and extents of all items, accessories, and trim. Label manufactured items by product name.
      b. Include project-specific dimensioned details drawn to scale showing conditions not detailed on the product data; or that are detailed, but not in a manner specific to the project. Cross-reference details to plans and elevations.
   3. Samples:

a. Submit at least 6-inch long by full panel width representative samples of each roof panel type, color, finish, and variety.
b. Submit at least 6-inch long representative samples of each accessory and trim type, color, finish, and variety. Include fasteners and exposed accessories.
c. Submit samples of all supporting framework components (e.g. rails, clips, brackets, subgirts), necessary for a complete installation.

B. Informational Submittals: Submit the following for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
1. Manufacturer's Instructions: Submit manufacturer-prepared published instructions for proper installation of furnished roof panels.
a. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.
b. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.
2. Delegated Design Submittals: Together with shop drawings, submit engineering calculations demonstrating conformance to the Contract Documents and all impacts of delegated design scope of work on other work.
a. Calculations must be explicit and legible and must incorporate distinct cross-references to submitted shop drawings in sufficient quantity to render the calculations readily intelligible and reviewable.
b. At a minimum, calculations must include design loads; section-property computations; analysis of fasteners, anchors, attachments, and connectors; and signature and seal of the licensed professional engineer responsible for preparing them.
c. Test reports are not an acceptable substitute for calculations and are returned to the Contractor without review or responsive action, except to record non-conformance with this requirement.
3. Qualification Statements: Submit written descriptions confirming experience specified in QUALITY ASSURANCE article below.

C. Closeout Submittals: Submit the following to the Architect as a condition of project closeout.
1. Warranty Documentation: Submit final warranties signed by the manufacturer's representative with complete terms indicated for all warranties covering items furnished or installed under this specification section.

1.5 QUALITY ASSURANCE

A. Source Limitations:
1. Roof panels must be obtained through one source from the same manufacturer (to ensure compatibility, regulatory conformance, and a warrantable installation).

a. Certain items may be obtained from more than one manufacturer, but only when used for separate installations.
b. Items provided for each different installation must be obtained from the same source and manufacturer.

2. Provide secondary materials, components, accessories and other items from sources required, recommended, or accepted by the primary manufacturer for actual in-service conditions applicable to the project.

B. Regulatory Requirements:
1. Fire Resistance Rating: Roof coverings must conform to UL 790 fire resistance requirements for Class A rating. (effective against severe fire test exposures)

C. Qualifications:
1. Manufacturer: Company or individuals must have at least 10 years' experience manufacturing roof panels installed on at least 200 previous projects similar to this project in size, material, design, and complexity.
2. Installer: Company or individuals must have at least 5 years' experience installing roof panels for at least 30 previous projects similar to this project in size, material, design, and complexity.
3. Supervisors: Individuals must have at least 7 years' experience installing roof panels for at least 30 previous projects similar to this project in size, material, design, and complexity, including at least 2 years' supervisory experience directing and leading roof panel installers.
4. Engineer: Must be a licensed professional structural engineer registered to practice in California having at least 10 years' experience performing the kind of engineering services indicated for at least 20 previous projects similar to this project in size, material, design, and complexity.

1.6 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
2. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items as shipped and in conformance with manufacturer's instructions and other requirements and recommendations for storage. Furnish adequate dunnage and bracing during storage.
1. Prevent stored items from contacting the floor or ground, from soiling and staining, and from deterioration and damage.
2. If items are not stored in an enclosed location, then cover the tops and sides with securely-tied, waterproof, and breathable covers. Unvented polyethylene tarpaulins do not qualify as breathable covers and are prohibited. (due to potential accumulation of moisture beneath tarpaulin during certain environmental conditions)

3. Incline covered items to ensure maximum drainage of accumulated moisture.
4. Do not leave items uncovered where they might be exposed to weather or become wet; or exposed to other sources of deterioration and damage.

C. Handling: Handle items in conformance with manufacturer's instructions and other requirements and recommendations, and in a manner that that prevents damage.

D. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective roof panels with undamaged new roof panels that do not exhibit deterioration, damage, or defects.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

1.7 WARRANTY

A. Manufacturer Warranty: Furnish to the Owner a written manufacturer warranty for products, components, and accessories against all patent and latent defects, and incipient and catastrophic failure for 5 years; and for finishes against color fading, chalking, cracking, checking, peeling, and adhesive failure for 20 years.

B. Installer Guarantee: Furnish to the Owner a written guarantee for the work of this specification section against all defects in materials and workmanship for 2 years from date of acceptance. Guarantees must be properly prepared and signed on the guarantee form in Division 01.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide products manufactured by one of the following, or equal.
1. AEP Span.
2. CENTRIA, Inc.
3. Metal Sales Manufacturing Corp.
4. Morin.
5. NorthClad.
6. Steelogic LLC.

B. Fabricators: Shop-fabricated panels are prohibited.

2.2 ROOF PANELS

A. Description: Pre-finished, formed metal roofing panels with vertical panel edges, flat panel between panel edges, and standing seam joints between panels.

B. Restrictions: Minimum slope must be at least 2:12.

C. Product: “Design Span hp” manufactured by AEP SPAN, or equal.

D. Requisite Properties:
   1. Sizes: Indicated on the Drawings.
   2. Material Thickness: At least 0.032-inch thick pre-painted aluminum sheet.
   3. Coverage: 12 inches.
   4. Depth: 1-3/4 inches.
   5. Exposed Finish: Manufacturer’s standard PVDF 3-coat color finish; color selected by the Architect from the manufacturer’s standard colors.
   6. Bottom Side Finish: Manufacturer's standard pretreatment and white or light-colored acrylic or polyester backer finish consisting of both prime and wash coats for a total DFT of at least 0.5-mil.
   7. Panel Texture: Smooth.
   8. Protection: Apply strippable film to the top side of the painted coil to protect the finish during fabrication, shipping and field handling. Remove strippable film just before installation.

E. Metallic Finishes: Panels, components, and accessories having a metallic finish must be finished such that the metallic finish directionality (grain) of all components runs in the same direction when installed. Color variation caused by failure to comply with this requirement is non-conforming work.

2.3 ACCESSORIES

A. Flashing, Trim, and Closures: Fabricated from same material as panels.
   1. Provide flashing, trim, and closures required to seal against weather and to match finished appearance, including bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers.
   2. Flashing, trim, and closure finish must match adjacent panel finish.

B. Gaskets and Seals used in Panel Assembly: Supplied, required, recommended, or accepted by the manufacturer to conform to specified performance criteria; color selected by the Architect from manufacturer’s standard colors.

C. Edge Members and Perimeter Extrusions: Extruded aluminum at least 0.063-inch thick, with integral weather-stripping and finish matching adjacent panels.

D. Clips and Fasteners: Concealed, non-corrosive, non-deteriorating clips and fasteners of quantity and type required, recommended, or accepted by manufacturer and that are that are compatible with roof panel faces.

E. Fastenings: Provide backings, inserts, loose connection hardware, fasteners, anchors, attachments, connectors, and other items supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.
   1. Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
   2. Reinforce framing members as required to receive fastener threads.
   3. Exposed fasteners are prohibited on faces exposed to view. Provide concealed fasteners and expansion provisions.

F. Other Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

2.4 FABRICATION

A. Fabricate flashing and trim in conformance with SMACNA publication "*Architectural Sheet Metal Manual*" requirements for design, dimensions, metal, and other characteristics.
   1. Form exposed sheet metal accessories without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
   2. Fabricate cleats and attachment devices from the same material as the accessory being anchored, or from compatible, noncorrosive metal required or recommended by metal roof panel manufacturer.
   3. Exposed fasteners are prohibited from faces of accessories exposed to view.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification:
   1. Verify in-place supporting and adjacent construction conforms to the manufacturer's requirements or recommendations and satisfies all other conditions that might affect the quality of installation or the durability, appearance, or performance of installed and adjacent items.
   2. Verify items penetrating roof panels are installed.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.

2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 INSTALLATION

A. General Requirements:
   1. Install roof panels using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
   2. Set items true to line, to required levels and lines, and plumb, level, and square, without warp or rack, with flush well-fitted joints, and in alignment with adjacent construction
   3. Completed work must match approved samples and mockups, as accepted by the Architect.
   4. Installed roof panels must be warrantable. Do not install, correct, or replace roof panels in a manner that results in any warranty or guarantee becoming void.

B. Special Techniques:
   1. Provide manufacturer's standard pressure-equalized, rainscreen-principle system with vertical channel that provides support and complete secondary drainage system, draining at base of wall.
   2. Install panels perpendicular to girts and subgirts unless otherwise indicated. Securely fasten panels and other components in place with provisions for thermal and structural movement. Use concealed fasteners and anchorages where possible. Provide washer head fasteners with bonded sealing washers where required to protect metal surfaces and to make a weathertight connection.
   3. Install roof panels to allow individual panels to "free float" and be installed and removed without disturbing adjacent panels. Leave joints uniform-width with open reveals.
   4. Form closely-fitted joints with exposed connections accurately located and secured.
   5. Provide uniform-width perimeter reveals and opening sealants and joint fillers as indicated.
   6. Flash and seal panels with weather closures at perimeter of openings. Install flashing and trim as roof panel work proceeds.
   7. Do not apply sealants to joints unless otherwise indicated on Drawings.
   8. Where weathertight panel joints are required, install concealed gaskets, flashings, joint fillers, and insulation as panel installation progresses. Comply with the requirements of Section 07 92 00 for installing sealants during panel installation.

C. Interface with Adjacent Items: Provide materials, components, and accessories normally furnished or necessary to securely attach roof panels to supporting construction.

D. Installation Tolerances: Install roof panels within the following tolerance variations.

1. Squareness: Not more than 1/8-inch difference in diagonal measurements.
2. Maximum Offset between Components at Joints: 1/16-inch except that offset are not allowed at welded joints.
3. Maximum Misalignment of Adjacent Members: 1/16-inch.
4. Maximum Bow: 1/8-inch in 48 inches.
5. Maximum Deviation from Plane: 1/16-inch in 48 inches.

3.3 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
   1. written descriptions of non-conforming, damaged, and defective work;
   2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
   3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.4 CLEANING

A. Cleaning Work: After installation, correction, and repair are complete, remove strippable film or other temporary protection. Promptly remove from exposed metal surfaces anything that might interfere with uniform oxidation or weathering. Clean all visible surfaces in a manner that does not result in any warranty or guarantee becoming void.
   1. Use cleaning materials, equipment, and accessories supplied, and means, methods, techniques, and procedures required, recommended, or accepted by the manufacturer.
   2. Do not use cleaning materials or procedures known to change, or that might change, the appearance of exposed finishes or adjacent surfaces; or cause deterioration or damage to exposed finishes or adjacent surfaces.
   3. Protect adjacent surfaces not being cleaned from staining, deterioration, damage, or other detrimental effects caused by cleaning.
   4. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be cleaned to the Architect's acceptance.

B. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

3.5 PROTECTION

A. Protect installed roof panels in place from soiling, deterioration, and damage until Substantial Completion.

B. Do not store anything adjacent to or against installed roof panels unless they are protected from damage, as accepted in writing by the manufacturer's representative. Do not use installed roof panels as work surfaces.

C. Remove protection when it's no longer needed and before Substantial Completion.

END OF SECTION

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SECTION 07 84 00 – FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Through-penetration firestop systems.
2. Fire-resistive joint systems (fire calks).
3. Perimeter fire-resistive joint systems (fire safing).
4. Surface preparation.
5. Installation materials.
6. Site tests and inspections.
7. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

1.2 REFERENCES

A. Abbreviations and Acronyms:
1. UL: Underwriter's Laboratories.

B. Definitions:
1. Manufacturer: Means the firestopping manufacturer, unless otherwise indicated.
2. Fire Partition Means construction designed and tested to resist the passage of fire for a prescribed time, specifically at fire barriers, fire walls, shafts, exit enclosures, smoke barriers, corridor construction and other construction assemblies.
3. L-Rating: Means the amount of air or cold smoke that can leak through a penetration, when tested in conformance with UL 1479.
4. F-Rating: Means the time a penetration firestop system prevents the passage of fire through a penetration, when tested in conformance with ASTM E 814 or UL 1479.
5. T-Rating: Means the time a firestop system, including the penetrating item, limits the maximum temperature rise to 325 deg. F above its initial temperature through the penetration on the non-fire side, when tested in conformance with ASTM E 814 or UL 1479.
6. Assembly Rating: Means the combination of T- and F-ratings in an assembly, with F equaling T, when tested in conformance with ASTM E 1966 or UL 2079.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Assisted by the selected manufacturer, choose firestopping components, products, and materials that correspond to selected firestopping systems shown by reference designations to
   a. Underwriters Laboratories, as listed in UL publication, "*Fire Resistance Directory*".
   b. Intertek's ETL SEMKO Division, as listed in its Omega Point Laboratories publication, "*Directory of Listed Building Products, Materials, & Assemblies*".
2. Where modifications to tested assemblies are necessary to suit project conditions or address applications for which there are no tested systems, obtain engineering judgments from the firestopping manufacturer derived from similar qualified tested system designs and other testing.
   a. Submit engineering judgments for review and approval and obtain written acceptance of modifications prior to submitting shop drawings to the Architect.
   b. Engineering judgment documents must conform to International Firestop Council for Evaluating Firestop Systems Engineering Judgments requirements.
3. Coordinate openings and penetrating items to ensure installed firestopping conforms to specified requirements and the selected firestop system testing laboratory designation.
   a. Coordinate sizing of sleeves, openings, core-drilled holes, and cut openings to accommodate firestop systems in conformance with the manufacturer's requirements and recommendations.
   b. Provide exposed firestopping material colors selected by the Architect from the standard color range currently available from the manufacturer. Custom colors are prohibited.

B. Acoustical Requirements: Provide non-hardening resilient firestop material at penetrations, sleeves, and passthroughs in acoustic construction assemblies.

C. Sequencing: After firestopping installation, maintain ambient conditions within a range required, recommended, approved, or accepted by the manufacturer until Final Completion.

1.4 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data: Submit manufacturer's product data, specifications, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs) and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
   2. Shop Drawings: Submit project-specific key plans showing firestopping installations.
   3. Firestopping Schedule: Submit firestopping schedule indicating firestopping types, laboratory tested assembly numbers, protected elements including sizes, materials, and minimum hourly fire-resistance rating for each fireproofed item. Cross-reference firestopping schedule to key plans.

B. Informational Submittals: Submit the following for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
   1. Manufacturer's Instructions: Submit manufacturer-prepared published instructions for proper installation of furnished firestopping.
      a. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.
      b. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.
   2. Qualification Statements: Submit written descriptions confirming experience specified in QUALITY ASSURANCE article below.

1.5 QUALITY ASSURANCE

A. Source Limitations:
   1. Firestopping must be obtained through one source from the same manufacturer (to ensure compatibility and a uniform appearance).
      a. Certain items may be obtained from more than one manufacturer, but only when used for separate installations.
      b. Items provided for each different installation must be obtained from the same source and manufacturer.
   2. Provide secondary materials, components, accessories and other items from sources required, recommended, or accepted by the primary manufacturer for actual in-service conditions applicable to the project.

B. Qualifications:
   1. Installer: Company or individuals must have at least 5 years' experience installing firestopping for at least 30 previous projects similar to this project in size, material, design, and complexity. Installers and supervisors must be
      a. authorized, certified, licensed, or otherwise qualified by the manufacturer for at least the past 5 consecutive years as having the necessary experience, personnel, and training to install or apply the manufacturer's products, including all related components and accessories; and
      b. approved by FM Approvals in conformance with FMG publication Class Number 4991, "*Approval Standard for Approval of Firestop Contractors*" or qualified by UL in conformance with its "*Qualified Firestop Contractor Programs*".
      c. Only personnel trained and certified by the manufacturer in the proper installation or application techniques may supervise or perform any of the work of this specification section.
   2. Supervisors: Individuals must have at least 7 years' experience installing firestopping for at least 30 previous projects similar to this project in size, material, design, and complexity, including at least 2 years' supervisory experience directing and leading firestopping installers.

C. Field Samples: Include *in-situ* mockups as part of the work of this specification section.
   1. The Architect reviews field samples for conformance to the Contract Documents and approves or rejects them as the standard by which subsequent work is evaluated.
   2. Revise field samples and repeat reviews, including arranging all revisions and paying all revision costs, until accepted in writing by the Architect. Final acceptance of firestopping is made from field samples.
   3. After acceptance, promptly identify and protect field samples for reference until Substantial Completion.
   4. Approved field samples may remain part of the work after being identified for future reference.

1.6 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
   1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
   2. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items as shipped and in conformance with manufacturer's instructions and other requirements and recommendations for storage. Furnish adequate dunnage and bracing during storage.
   1. Prevent stored items from contacting the floor or ground and from deterioration and damage.
   2. If items are not stored in an enclosed location, then cover the tops and sides with securely-tied, waterproof, and breathable covers. Unvented polyethylene tarpaulins do not qualify as breathable covers and are prohibited. (due to potential accumulation of moisture beneath tarpaulin during certain environmental conditions)
   3. Incline covered items to ensure maximum drainage of accumulated moisture.
   4. Do not leave items uncovered where they might be exposed to weather or become wet from rain, mist, relative humidity, condensation, frost, and other sources of moisture; or exposed to other sources of deterioration and damage, including heat and sudden changes in temperature, and UV exposure beyond manufacturer-recommended limits.

C. Handling: Handle items in conformance with manufacturer's instructions and other requirements and recommendations, and in a manner that that prevents damage.
   1. Avoid damage to packaging and containers, and contamination of contents.
   2. Rotate inventory; do not use items the shelf life of which is expired.

D. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective firestopping materials with undamaged new firestopping materials that do not exhibit deterioration, damage, or defects.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

1.7 PROJECT CONDITIONS

A. Ambient Conditions: Install firestopping only when ambient temperature, RH, and other environmental conditions fall within ranges required, recommended, or accepted by the manufacturer.
   1. Do not install firestopping during rain or snow, fog or mist; or when rain or snow is predicted within 24 hours of installation.
   2. Proceed only when there is no threat of impending precipitation, and both current and forecasted weather conditions conform to those required, recommended, or accepted by the manufacturer.
   3. Do not apply firestopping when
      a. ambient temperature is below 45 deg. F or more than 90 deg. F during application, and for at least 8 hours after;
      b. surface temperatures are less than 40 deg. F or greater than 120 deg. F; and
      c. surface temperatures are 5 deg. F or less above the dew point.

B. Existing Conditions:
   1. Surface Conditions: Surfaces receiving firestopping must be dry. Install firestopping only when substrate moisture content and surface temperature fall within ranges required, recommended, or accepted by the manufacturer.
   2. Ventilation: Maintain adequate ventilation during and after installation and curing, setting, or drying. Where natural ventilation is inadequate, use forced-air circulation or mechanical ventilation as necessary for the installations indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide products manufactured by one of the following, or equal.
   1. 3M Fire Protection Products.
   2. Hilti, Inc.
   3. Specified Technologies, Inc.

2.2 FIRESTOPPING ASSEMBLIES

A. Description:
   1. Through-Penetration Firestop Systems: Provide firestop systems tested and identified in UL's "*Fire Resistance Directory*" product Category XHEZ, or equal.
   2. Fire-Resistive Joint Systems (fire calks): Provide firestop systems tested and identified in UL's "*Fire Resistance Directory*" product Category XHBN, or equal.

3. Perimeter Fire-Resistive Joint Systems (safing insulation): Provide firestop systems tested and identified in UL's "*Fire Resistance Directory*" product Category XHDG, or equal.

B. Requisite Properties:
1. F-Rated Firestop Systems: Provide firestop systems in fire partitions having an F rating that meets or exceeds the fire-resistance rating of the penetrated construction, but not less than one-hour.
2. T-Rated Firestop Systems: In fire-resistive floor-ceiling or roof-ceiling construction, or other constructions where penetrating items pass through occupied areas and may contact combustible materials, provide firestop systems having both an F- and a T-rating, determined in conformance with ASTM E 814 or UL 1479. T-rated assemblies are required where the following conditions exist with exceptions.
   a. Where firestop systems protect floor penetrations located outside of wall cavities.
   b. Where firestop systems protect floor penetrations located outside fire-resistive shaft enclosures.
   c. Where firestop systems protect penetrations located in fire-resistive construction containing doors required to have a temperature-rise rating.
   d. Where firestop systems protect penetrating items larger than a 4-inch diameter nominal pipe or 16 square inches in overall cross-sectional area.
3. L-Rated Firestop Systems: Where firestop systems are indicated in smoke barriers and elsewhere, provide penetration firestop systems with an L-rating of not more than 5.0 cubic feet per minute per square foot both at ambient temperatures and at 400 deg. F.
4. Firestopping Exposed to Traffic, Moisture, or Physical Damage: Provide products that do not deteriorate after curing.
5. Plumbing and Wet-Pipe Sprinkler System Piping Penetrations: Provide moisture-resistant penetration firestop systems.
6. Penetrations with Insulated Piping: Provide penetration firestop systems that do not require piping insulation removal.
7. Floor penetrations with Annular Spaces Exceeding 4 inches Wide and Exposed to Possible Loading and Traffic: Provide firestop systems that support floor loads involved, either by installing floor plates or by other means.
8. Surface-Burning Characteristics: Provide firestopping having a maximum FSI Value of 0 and a maximum SDI Value of 0 (Class A), when tested in conformance with ASTM E 84.

2.3 MATERIALS

A. Latex Sealant: Single-component latex formulations that after cure do not re-emulsify during exposure to moisture.

B. Silicone Sealant: Single-component, silicone-based, neutral-curing elastomeric sealants. Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces; non-sag formulation for openings in walls and other vertical and overhead surfaces.

C. Silicone Foam: Multicomponent, silicone-based liquid elastomer that, when mixed, expands and cures in place to produce a flexible, non-shrinking foam.

D. Intumescent Putty: Non-hardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

E. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

F. Intumescent Blocks: Intumescent flexible block based on a two-component polyurethane foam

G. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized steel sheet.

H. Pillows and Bags: Reusable heat-expanding pillows and bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives.

I. Pre-formed Mineral Wool: Designed to fit flutes of metal decking and the gap between the top of wall and metal decking as a backer for spray material.

J. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors, consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket, including similar devices.

K. Pre-Installed Firestop Devices: Factory-assembled devices for use with noncombustible and combustible pipes (closed and open systems), conduit, and cable bundles penetrating concrete floors or gypsum board walls.

L. Metal Track Firestopping:
   1. Description: Top- and bottom-of-wall metal tracks to fills gaps between the metal and concrete surfaces and help seal out fire and smoke sound drafts.
   2. Product: “Firestop Top Track Seal CFS-TTS” manufactured by Hilti, or equal.

M. Fire Rated Cable Pathways:
   1. Description: Gangable device modules consisting of steel raceways with intumescent foam pads requiring no additional action to achieve fire and leakage ratings, including plugs, twisting closure, putty, pillow, or sealant.
   2. Products: “EZ-PATH Series 44+ Fire Rated Pathway” manufactured by Specified Technologies, Inc., or equal.
   3. Requisite Properties:

a. Size: 4 inches wide by 4-5/8 inches high by 14 inches long.
b. Material: 0.059-inch BMT (MSG 18) galvanized steel sheet.

2.4 ACCESSORIES

A. Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

2.5 MIXING

A. Open firestopping containers only as required for use and mix only in designated areas.

B. Thoroughly agitate and stir materials to a uniform and smooth consistency suitable for proper installation.

C. Do not reduce, alter, or introduce foreign materials into firestopping, except in conformance with manufacturer's instructions and other requirements and recommendations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification:
1. Verify in-place construction, project conditions, and the work of other specification sections conform to the manufacturer's instructions and other requirements and recommendations.
2. Verify substrates are dry and free of deleterious and other substances that might interfere with firestopping adhesion, appearance, or performance.

C. Evaluation and Assessment:
1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.
2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 PREPARATION

A. Protection:
   1. Work Area Protection: Protect work areas from dust and other airborne contaminants during surface preparation and firestopping installation.
   2. Adjacent Material Protection: Protect adjacent surfaces against soiling and damage. Utilize drop cloths, shields, masking, barricades, and other items necessary to protect adjacent surfaces.

B. Substrate Preparation: Prepare substrates as required, recommended, or accepted by the manufacturer without limitation; and in a manner that does not result in any warranty or guarantee becoming void.

3.3 INSTALLATION

A. General Requirements:
   1. Install firestopping using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
   2. Only install firestopping under conditions that ensure finishes are free from blemishes and defects.
   3. Provide smooth surfaces of uniform finish, color, appearance, and coverage. Fireproofing surfaces with cloudiness, spotting, holidays, runs, or other imperfections are prohibited and are rejected as non-conforming work.
   4. Do not exceed the application rates recommended by the manufacturer.
   5. Completed work must match approved samples and mockups, as accepted by the Architect.
   6. Installed firestopping must be warrantable. Do not install, correct, or replace firestopping in a manner that results in any warranty or guarantee becoming void.

B. Special Techniques:
   1. Prime substrates as required, recommended, approved, or accepted by the manufacturer, using the manufacturer's recommended products and methods.
      a. Confine primers to bond areas.
      b. Do not allow spillage and migration onto exposed surfaces
   2. Install forming, damming, and backing materials and other accessories as required to support fill materials during installation in the positions needed to produce cross-sectional shapes and depths required for indicated fire ratings.
   3. Verify wet film thickness of firestopping during application by taking numerous measurements with a wet film gage.
   4. After installing fill materials and allowing them to fully cure, remove forming materials and other accessories not indicated as permanent components of the firestopping systems.

a. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required achieving fire-resistance ratings indicated.
b. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
c. Where fill materials remain exposed after installation, produce uniform finished surfaces without substrates, undercoats, marks, or stains showing through. Produce sharp and even lines and color breaks.

3.4 FIELD QUALITY CONTROL

A. Site Inspections:
1. General: Include site inspections as part of the work of this specification section. The Owner's testing and inspection agency performs inspections.
a. Schedule and arrange all inspections.
b. Coordinate all work and the final construction schedule with all inspections.
c. Coordinate inspections with the work of other specification sections, and other specified, required, or necessary tests and inspections.
d. Furnish all work, equipment, tools, facilities, personnel, and controls necessary for each test and inspection.
e. Arrange inspections by notifying the Owner, the testing and inspection agency, the installer, the manufacturer's representative, and the Architect at least 5 business days before work is ready for testing or inspection.
f. Witness all site inspections.
g. Receive test and inspection reports and distribute to the installer and the manufacturer's representative.
h. When tests and inspections reveal defective items, repair defective work to the satisfaction of the manufacturer's representative and Architect, and re-test and re-inspect work without reimbursement from Owner until all work passes tests and inspections.
2. Required Inspections: Inspections are performed in conformance with the requirements of ASTM E 2174 (through penetration fire stops) and ASTM E 2393 (fire resistive joint systems and perimeter fire barriers).

3.5 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs, and re-inspection and re-testing costs, without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include

1. written descriptions of non-conforming, damaged, and defective work;
2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.6 CLEANING

A. Cleaning Work: Clean spills, stains, soiling, overspray, and fallout from adjacent surfaces.
   1. Use cleaning materials, equipment, and accessories supplied, and means, methods, techniques, and procedures required, recommended, or accepted by the manufacturer.
   2. Do not use cleaning materials or procedures known to change, or that might change, the appearance of exposed finishes or adjacent surfaces; or cause deterioration or damage to exposed finishes or adjacent surfaces.
   3. Protect adjacent surfaces not being cleaned from staining, deterioration, damage, or other detrimental effects caused by cleaning.
   4. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be cleaned to the Architect's acceptance.

B. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

3.7 PROTECTION

A. Protect installed firestopping in place from deterioration and damage until covering firestopping or Substantial Completion.

B. Do not store anything adjacent to or against installed firestopping unless it is protected from damage, as accepted in writing by the manufacturer's representative. Do not use installed firestopping surfaces as work surfaces.

C. Remove protection when it's no longer needed and before covering firestopping or Substantial Completion.

END OF SECTION

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SECTION 07 92 10 – INTERIOR JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Interior joint sealants.
   2. Surface preparation.
   3. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

B. Related Requirements:
   1. Section 09 81 33 for acoustical sealants.

1.2 REFERENCES

A. Definitions:
   1. Manufacturer: Means the sealant manufacturer, unless otherwise indicated.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Proposed substitution requests and submittals that change the quality (grade) or generic chemistry of specified sealants are prohibited and returned to the Contractor without review or responsive action, except to record non-conformance with this requirement.

B. Performance Requirements:
   1. Joint sealants must establish and maintain a continuous watertight seal without substrates staining or deterioration.
   2. Sealants installed in contact with porous substrates must demonstrate testing in conformance with ASTM C 1248 resulting in no staining to porous materials identical to those indicated for this project.

C. Scheduling: Schedule cleaning to prevent dust and other contaminants from falling on freshly-applied coatings.

1.4 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).

1. Product Data: Submit manufacturer's product data, specifications, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs) and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
2. Samples: Submit at least 6-inch long representative samples of each sealant variety in each selected color.

B. Informational Submittals: Submit the following for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
1. Manufacturer's Instructions: Submit manufacturer-prepared published instructions for proper installation of furnished joint sealants .
a. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.
b. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.
2. Qualification Statements: Submit written descriptions confirming experience specified in QUALITY ASSURANCE article below.

1.5 QUALITY ASSURANCE

A. Source Limitations:
1. Joint sealants must be obtained through one source from the same manufacturer (to ensure compatibility and a uniform appearance).
a. Certain items may be obtained from more than one manufacturer, but only when used for separate installations.
b. Items provided for each different installation must be obtained from the same source and manufacturer.
2. Provide secondary materials, components, accessories and other items from sources required, recommended, or accepted by the primary manufacturer for actual in-service conditions applicable to the project.

1.6 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
2. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items as shipped and in conformance with manufacturer's instructions and other requirements and recommendations for storage. Furnish adequate dunnage during storage.

C. Handling: Handle items in conformance with manufacturer's instructions and other requirements and recommendations, and in a manner that that prevents damage.
   1. Avoid damage to packaging and containers, and contamination of contents.
   2. Rotate inventory; do not use items the shelf life of which is expired.

D. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective sealant materials with undamaged new sealants materials that do not exhibit deterioration, damage, or defects.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

1.7 PROJECT CONDITIONS

A. Ambient Conditions: Install joint sealants only when ambient temperature, RH, and other environmental conditions fall within ranges required, recommended, or accepted by the manufacturer.
   1. Do not install joint sealants during rain or snow, fog or mist; or when rain or snow is predicted within 24 hours of installation.
   2. Proceed only when there is no threat of impending precipitation, and both current and forecasted weather conditions conform to those required, recommended, or accepted by the manufacturer.
   3. Do not apply joint sealants when
      a. ambient temperature is below 45 deg. F or more than 90 deg. F during application, and for at least 8 hours after;
      b. surface temperatures are less than 40 deg. F or greater than 120 deg. F; and
      c. surface temperatures are 5 deg. F or less above the dew point.

B. Existing Conditions:
   1. Surface Conditions: Surfaces receiving joint sealants must be dry. Install joint sealants only when substrate moisture content and surface temperature fall within ranges required, recommended, or accepted by the manufacturer.
   2. Illumination: Provide permanent lighting or illuminate work spaces to at least the same level occurring in the room or space after Final Completion.

C. Other Conditions: Do not apply coatings where dust is generated, or liquids are sprayed; or when windy conditions exist that may cause coatings to be blown onto vegetation or other unintended surfaces.

PART 2 - PRODUCTS

2.1 INTERIOR JOINT SEALANTS

A. Single-Component Damp Location Sealant:

1. Description: Medium or high modulus mildew-resistant silicone sealant conforming to ASTM C 920 requirements for Type S, Grade NS, Class 25, Use NT, A or O sealant, as applicable.
2. Products: Provide one of the following, or equal.
   a. "786" manufactured by Dow Corning Corp.
   b. "Sanitary SCS 1700" manufactured by Momentive Performance Materials, Inc.
3. Colors: White or clear, as selected by the Architect.

B. General Purpose Interior Sealant:
1. Description: Siliconized acrylic-latex sealant conforming to ASTM C 834 requirements for Type OP, Grade NF classification, as required.
2. Products: Provide one of the following, or equal.
   a. "Sonneborn Sonolac" manufactured by BASF Building Systems.
   b. "AC-20+Silicone" manufactured by Pecora Corp.
   c. "Tremflex 834" manufactured by Tremco, Inc.
3. Colors: Selected by the Architect from the manufacturer's standard colors.

2.2 ACCESSORIES

A. Primer and Surface Cleaners:
1. Application: Applied to enhance and strengthen sealant adhesion to porous and nonporous substrates; and help ensure proper joint preparation
2. Porous and Cementitious Surfaces: "1200 OS Primer" manufactured by Dow Corning Corp., or equal.
3. Other Surfaces: "Construction Primer P" manufactured by Dow Corning Corp., or equal.

B. Masking Tape: Provide paper masking tape manufactured by 3M, or equal, unless another kind is supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project

C. Other Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

2.3 MIXING

A. Open sealants containers only as required for use.

B. Do not reduce, alter, or introduce foreign materials into sealants, except in conformance with manufacturer's instructions and other requirements and recommendations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification:
   1. Verify in-place construction, project conditions, and the work of other specification sections conform to the manufacturer's instructions and other requirements and recommendations.
   2. Verify joint dimensions and joint backer sizes conform to width-to-depth ratios, neck dimensions, and surface bond areas required, recommended, or accepted by the manufacturer.
   3. Verify substrates are dry and free of deleterious and other substances that might interfere with joint sealant adhesion, appearance, or performance.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.
   2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 PREPARATION

A. Protection:
   1. Work Area Protection: Protect work areas from dust and other airborne contaminants during surface preparation and joint sealant installation.
   2. Adjacent Material Protection: Protect adjacent surfaces against soiling and damage. Utilize drop cloths, shields, masking, barricades, and other items necessary to protect adjacent surfaces.

B. Substrate Preparation:
   1. Prepare substrates in conformance with ASTM C 1193 and as required, recommended, or accepted by the manufacturer without limitation; and in a manner that does not result in any warranty or guarantee becoming void.
   2. Remove loose materials and foreign matter that may impair sealant adhesion.
   3. Clean and prime substrates as required, recommended, or accepted by the manufacturer, using the manufacturer's recommended products and methods.
      a. Confine primers to bond areas.
      b. Do not allow spillage and migration onto exposed surfaces

3.3 INSTALLATION

A. General Requirements:
   1. Install joint sealants in conformance with ASTM C 1193 using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
   2. Only install joint sealants under conditions that ensure finishes are free from blemishes and defects.
   3. Provide smooth surfaces of uniform finish, color, appearance, and coverage. Joint sealant surfaces with cloudiness, spotting, holidays, runs, or other imperfections are prohibited and are rejected as non-conforming work. Produce sharp and even lines and color breaks.
   4. Completed work must match approved samples and mockups, as accepted by the Architect.
   5. Installed joint sealants must be warrantable. Do not install, correct, or replace joint sealants in a manner that results in any warranty or guarantee becoming void.

3.4 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
   1. written descriptions of non-conforming, damaged, and defective work;
   2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
   3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect’s acceptance.

3.5 CLEANING

A. Cleaning Work: Clean sealant from adjacent surfaces.
   1. Use cleaning materials, equipment, and accessories supplied, and means, methods, techniques, and procedures required, recommended, or accepted by the manufacturer.

2. Do not use cleaning materials or procedures known to change, or that might change, the appearance of exposed finishes or adjacent surfaces; or cause deterioration or damage to exposed finishes or adjacent surfaces.
3. Protect adjacent surfaces not being cleaned from staining, deterioration, damage, or other detrimental effects caused by cleaning.
4. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be cleaned to the Architect's acceptance.

B. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

END OF SECTION

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DIVISION 08

OPENINGS

SECTION 08 12 13 – STANDARD HOLLOW METAL FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Standard hollow metal door frames.
   2. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

B. Related Requirements:
   1. Section 08 71 00 for door hardware.

1.2 REFERENCES

A. Abbreviations and Acronyms:
   1. BMT: Base Metal Thickness.
   2. DHI: Door Hardware Institute.
   3. HM: Hollow Metal.
   4. MSG: Manufacturer's Standard Gage.
   5. DI: Steel Door Institute.

B. Definitions:
   1. Manufacturer: Means the door frame manufacturer, unless otherwise indicated.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate building opening tolerances with door frame manufacturing and erection tolerances.
   2. Coordinate hardware preparations, handing, and reinforcement requirements and locations with the Drawings, door schedule, and selected hardware sets.

1.4 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data: Submit manufacturer's product data, specifications, typical installation details, and all other information necessary to show conformance to the Contract

Documents, excluding material safety data sheets (MSDSs) and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.

2. Door Schedule: Submit schedule showing opening identification symbols and door and frame types and sizes, including thickness, swing, fire-resistance rating label requirements, undercuts, and finishes. Use the same reference numbers for openings and details as the Drawings.
3. Shop Drawings: Include project-specific dimensioned details drawn to scale showing conditions not detailed on the product data; or that are detailed, but not in a manner specific to the project. Cross-reference details to door schedule.

B. Informational Submittals: Submit the following for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
1. Manufacturer's Instructions: Submit manufacturer-prepared published instructions for proper installation of furnished door frames.
a. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.
b. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.
2. Qualification Statements: Submit written descriptions confirming experience specified in QUALITY ASSURANCE article below.

1.5 QUALITY ASSURANCE

A. Source Limitations:
1. Door frames must be obtained through one source from the same manufacturer (to ensure compatibility, regulatory conformance, and a warrantable installation).
a. Certain items may be obtained from more than one manufacturer, but only when used for separate installations.
b. Items provided for each different installation must be obtained from the same source and manufacturer.
2. Provide secondary materials, components, accessories and other items from sources required, recommended, or accepted by the primary manufacturer for actual in-service conditions applicable to the project.

B. Quality Standard Requirements:
1. Manufacturing Tolerances: Comply with the requirements of ANSI/SDI publication ANSI/SDI A250.8, "*Recommended Specifications for Standard Steel Doors and Frames"*.
2. Door Frame Installation Standards:
a. Install fire-resistance rated frames in conformance with NFPA 80, "*Standard for Fire Doors and Other Opening Protectives*".

b. Install other frames in conformance with of ANSI A250.11, "*Recommended Erection Instructions for Steel Frames*".

3. Hardware Preparations and Reinforcement: Comply with the requirements of ANSI/SDI A250.6, "*Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames*" with reinforcing plates fabricated from the same material as door face sheets.
4. Door Hardware Installation Standards: Install door frame hardware in conformance with ANSI/DHI A115-IG, "*Installation Guide for Doors and Hardware*".

C. Qualifications:
1. Manufacturer: Company or individuals must have at least 10 years' experience manufacturing door frames installed on at least 200 previous projects similar to this project in size, material, design, and complexity. Manufacturer must be a current member of SDI.
2. Installer: Company or individuals must have at least 5 years' experience installing door frames for at least 30 previous projects similar to this project in size, material, design, and complexity. Installer must be a current member of SDI.
3. Supervisors: Individuals must have at least 7 years' experience installing door frames for at least 30 previous projects similar to this project in size, material, design, and complexity, including at least 2 years' supervisory experience directing and leading door frame installers.

1.6 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
2. Unload and store only inspected and accepted items.
3. Across the bottom of welded frames, at least 2 removable spreader bars must be tack welded to jambs and mullions.
4. Frames must be palletized, wrapped, or crated to provide protection during transit and site storage.

B. Storage: Store unloaded items as shipped, upright, and indoors within dry, well-ventilated, broom-cleaned, and partially- or permanently-enclosed storage areas.

C. Damaged Item Replacement: Promptly remove and replace items that are deteriorated, damaged, or defective with undamaged new items that do not exhibit deterioration, damage, or defects.

D. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide products manufactured by one of the following, or equal.
   1. Allegion PLC.
   2. ASSA ABLOY.
   3. Door Components, Inc.
   4. MPI Custom Steel Doors and Frames.
   5. Republic Doors and Frames.

2.2 STANDARD HOLLOW METAL FRAMES

A. Description: 3-sided (open), fully welded masonry (universal) and flush drywall standard HM frames conforming to the requirements of Steel Door Institute publication SDI-100, "*Recommended Specifications for Standard Steel Doors and Frames"*.

B. Products: "Steelcraft" frames manufactured by Allegion, or equal.
   1. Single Egress Door HM Frames: "F-Series" frames, or equal.
   2. Double Egress Door HM Frames: "FE-Series" frames, or equal.
   3. Cross-Corridor Door HM Frames: "DE-Series" frames, or equal.
   4. Stainless Steel HM Frames: "FS-Series" frames, or equal.

2.3 COMPONENTS

A. Materials:
   1. Frames with an Uncoated Finish (Bare or Natural Finish): Fabricate from zinc coated (HDG) steel sheet or from stainless steel sheet, as indicated.
   2. Exterior Frames with a Painted Finish and Interior Frames Installed in Wet or High Humidity Locations (including shower rooms and toilet rooms): May be fabricated from either zinc-iron alloy coated (galvannealed) steel sheet or stainless steel sheet.
   3. Interior Frames Installed Elsewhere: Fabricate from uncoated CRS sheet.
   4. Sidelight and Transom Frames: Fabricate from the same material, thickness, and finish as the adjacent door frame.

B. Material Thickness:
   1. HM Frames for Level 1 and Physical Performance Level C (Standard Duty) Doors: Fabricate from at least 0.0478-inch BMT (MSG 18) uncoated and zinc-coated steel sheet; or from at least 0.0500-inch (USSG 18) stainless steel sheet.
   2. HM Frames for Level 2 (Heavy Duty) and Physical Performance Level B, and for Level 3 and Physical Performance Level B (Extra Heavy Duty) Doors: Fabricate from at least 0.0598-inch BMT (MSG 16) uncoated steel and zinc-coated steel BMT; or from at least 0.0625-inch BMT (USSG 16) stainless steel sheet.

3. HM Frames for Level 3 and Physical Performance Level B (Extra Heavy Duty) Doors: Fabricate from at least 0.0598-inch BMT (MSG 16) uncoated steel and zinc-coated steel BMT; or from at least 0.0625-inch BMT (USSG 16) stainless steel sheet.
4. HM Frames for Level 4 and Physical Performance Level A (Maximum Duty) Doors: Fabricate from at least 0.0747-inch BMT (MSG 14) uncoated and zinc-coated steel sheet, or at least 0.0781-inch (USSG 14) stainless steel sheet.
5. Other HM Frames: Fabricate from at least 0.0598-inch BMT (MSG 16) uncoated steel and zinc-coated steel BMT; or from at least 0.0625-inch BMT (USSG 16) stainless steel sheet.

C. Profiles:
1. Types: Indicated on the Drawings.
2. Throat Openings:
   a. Butted Frames: Equal to the wall or partition type thickness minus twice the frame return dimension, unless otherwise indicated.
   b. Wrap-Around Frames: Equal to the wall or partition thickness, unless otherwise indicated.
3. Frame Depth:
   a. Butted Frames: Equal to the wall or partition thickness.
   b. Wrap-Around Frames: Equal to the throat opening plus twice the frame return dimension.
4. Frame Return Dimension: 1/2-inch.
5. Backbend Dimension (Second, Double, or Drywall Return Dimension): At least 3/8-inch.
6. Backbend Type: Indicated on the Drawings.
7. Face Dimension: Provide 4-inch face dimension at heads in CMU construction where required to maintain a masonry module; provide 2-inch face dimension at jambs. Provide 2-inch face dimension elsewhere, unless otherwise indicated.
8. Stop Dimension: 5/8-inch.
9. Rabbet Depth Dimension: Equal to 3/16-inch greater than the door thickness.
10. Opposite Door Rabbet Depth Dimension: 1-9/16 inches.
11. Soffit Dimension: Equal to the frame depth minus the sum of the rabbet dimensions.

D. Corners:
1. Welded HM Door Frames: Provide square-cut mitered or coped and mitered, set-up arc welded (SUA) and ground smooth, full profile welded frames (fully welded or continuously welded frames) for installation of frames as a complete unit. All corners must be watertight.
2. HM Frame Glazing Beads: Provide butted corners.

E. Hardware Preparations and Reinforcement: Provide HM frame hardware reinforcing and preparations in conformance with ANSI/SDI publications A250.6, "*Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames*" and A250.8, "*Recommended Specifications for Standard Steel Doors and Frames*".

2.4 ACCESSORIES

A. Head Reinforcement: For opening widths greater than 48 inches wide, provide channel or angle stiffeners fabricated from at least 0.0747-inch BMT (MSG 14) zinc coated (HDG) steel sheet or at least 0.0781-inch BMT (USSG 14) stainless steel sheet, as applicable.

B. Anchors:
   1. Masonry Anchors: Provide either 3/16-inch minimum diameter (SWG 7) galvanized carbon steel masonry wire anchors or at least 0.0598-inch BMT (MSG 16) zinc coated (HDG) steel sheet masonry tee anchors, as applicable.
   2. Existing Opening Anchors: Provide at least 16-gage welded pipe sleeve anchors with 0.0598-inch BMT (MSG 16) zinc coated (HDG) steel sheet straps designed specifically to add support for bolting frames into rough openings of an existing walls.
   3. Wood Stud Anchors: Provide either at least 0.0598-inch BMT (MSG 16) zinc coated (HDG) steel sheet anchors designed specifically for attachment to the wood studs of a rough opening.
   4. Metal Stud Anchors: Provide either at least 0.0598-inch BMT (MSG 16) zinc coated (HDG) steel sheet anchors designed specifically for attachment to the webbing of the closed steel studs built around the frame.
   5. Universal Stud Wall Anchors: Provide either at least 0.0598-inch BMT (MSG 16) zinc coated (HDG) steel sheet universal lock-in jamb anchors designed specifically for use in either wood or steel stud wall applications, as applicable.
   6. Base Anchors: Provide either at least 0.0598-inch (MSG 16) BMT zinc coated (HDG) steel sheet or at least 0.0625-inch BMT (USSG 16) stainless steel sheet base anchors, as applicable. Provide adjustable base anchors that allow for installation adjustment when the floor is not level.

C. Electrical Device Requirements: Make provisions for installation of electrified hardware and door electrical devices, and arrange so that wiring is readily installed, removed, and replaced.
   1. Provide cutouts and reinforcement required for installation of devices.
   2. Provide metal conduits or raceways to accommodate wiring between devices. (e.g., from electric hinge to other electric door hardware)

D. Glazing Stops:
   1. Fire-Rated Conditions: Provide 3/4-inch square channel glazing beads.
   2. Elsewhere: Provide 5/8-inch square channel glazing beads.
   3. Material Thickness: Fabricate from at least 0.0478-inch BMT (MSG 18) uncoated and zinc-coated steel sheet.

E. Silencers: Provide loose, 1/8-inch thick by 1/2-inch wide pressure-sensitive-adhesive-backed polychloroprene (Neoprene) or ethylene propylene diene monomer (EPDM) rubber silencers for field installation. Furnish at least 3 for each strike jamb and at least 2 for double door head. Do not provide silencers where they may interfere with other seals, including smoke & draft seals.

F. Filler: Provide material conforming to the requirements of ANSI/SDI publication A250.8, "*Recommended Specifications for Standard Steel Doors and Frames*". Use UL-listed materials in frames scheduled as having a fire-resistance rating.

G. Other Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

2.5 MATERIALS

A. Uncoated Carbon Steel Sheet:
   1. Frame Material: Finished CRS coil, sheet, and strip conforming to ASTM A 1008, CS Type B (commercial steel), exposed, temper rolled, regular matte surface finish (40 to 59 AA), and oiled (sheet must be thoroughly cleaned to remove the oil prior to painting).
   2. Hardware Reinforcements: HRS coil, sheet, and strip conforming to ASTM A 1011, CS Type B (commercial steel), as-rolled surface finish, with cut edges.

B. Zinc-Iron Alloy Coated (Galvannealed) Steel Sheet: ASTM A 653, CS Type B (commercial steel), with equal coating weight on each surface.
   1. Coating Weight (Mass) Designation: Provide at least a A60 (galvannealed) minimum coating weight (mass) designation.
   2. Surface Finish: Non-spangled matte finish.
   3. Surface Treatment: Provide mill phosphate surface treatment (paint-grip finish - provides enhanced lubricating characteristics).

C. Zinc Coated (HDG) Steel Sheet: ASTM A 653, CS Type B (commercial steel), with equal coating weight on each surface.
   1. Coating Weight (Mass) Designation: Provide at least a G90 (galvanized) minimum coating weight (mass) designation.
   2. Surface Finish: Provide regular spangle surface finish.
   3. Surface Treatment:
      a. Exterior Frames: Provide oil over chemical surface treatment (chemical treatment desired for humid-storage stain resistance and oil treatment needed for enhanced formability).
      b. Interior Frames: Provide oiled surface treatment (needed for enhanced formability).

2.6 FINISHES

A. Uncoated Steel HM Frames: Provide shop-applied phosphate (paint-grip) pre-treatment and baked on rust inhibitive primer. Primer must be compatible with either field-applied paint or field-applied coating systems specified in Division 09, as applicable.

B. Zinc Coated and Zinc-Iron Alloy Coated Steel and Stainless Steel HM Frames: Provide shop-applied bonderized pre-treatment. (not prime painted)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification: Verify in-place supporting and adjacent construction conforms to the manufacturer's requirements or recommendations and satisfies all other conditions that might affect the quality of installation or the durability, appearance, or performance of installed and adjacent items.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.
   2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 INSTALLATION

A. General Requirements:
   1. Install door frames in conformance with the quality standards publications using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
   2. Set items true to line, to required levels and lines, and plumb, level, and square, without warp or rack, with flush well-fitted joints, and in alignment with adjacent construction
   3. Perform drilling and fitting as required or necessary for an accurate fit and complete installation.
   4. Installed door frames must be warrantable. Do not install, correct, or replace door frames in a manner that results in any warranty or guarantee becoming void.

B. Special Techniques:
   1. Frames: Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
      a. Install frames with removable glazing stops located on secure side of opening.
      b. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.

c. Install door silencers in frames before grouting.
d. Provide setting spreaders, supplied by the installer, and leave intact until frames are set square and plumb within specified tolerances, and all anchors are securely attached and grouted where required.
e. Remove frame spreader bars only after frames re properly set and secured. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.
3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
4. Concrete Walls: Solidly fill space between frames and concrete with grout. Take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.
5. Ceiling Struts: Except where anchored to masonry or to other structural support at each jamb, extend struts vertically from top of frame at each jamb to overhead structural supports or substrates above frame.
   a. Bend top of struts to provide flush contact for securing to supporting construction.
   b. Provide adjustable wedged or bolted anchorage to frame jamb members.
6. Glazing: Comply with installation requirements and with the manufacturer's instructions. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches O.C. and not more than 2 inches on center from each corner.

C. Interface with Adjacent Items: Provide materials, components, and accessories normally furnished or necessary to securely attach door frames to supporting construction.

D. Installation Tolerances: Install frames within the following tolerance variations.
1. Maximum Out of Square: Not more than 1/16-inch, measured at rabbet on 90 degrees from jamb perpendicular to frame head.
2. Maximum Out of Alignment: Not more than 1/16-inch, measured at jambs on a horizontal line parallel to plane of wall.
3. Maximum Twist: Not more than 1/16-inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
4. Maximum Out of Plumb: Not more than 1/16-inch, measured on floor at jambs.

3.3 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
   1. written descriptions of non-conforming, damaged, and defective work;
   2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
   3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.4 CLEANING

A. Cleaning Work: Clean all visible door frame surfaces in a manner that does not result in any warranty or guarantee becoming void.
   1. Use cleaning materials, equipment, and accessories supplied, and means, methods, techniques, and procedures required, recommended, or accepted by the manufacturer.
   2. Do not use cleaning materials or procedures known to change, or that might change, the appearance of exposed finishes or adjacent surfaces; or cause deterioration or damage to exposed finishes or adjacent surfaces.
   3. Protect adjacent surfaces not being cleaned from staining, deterioration, damage, or other detrimental effects caused by cleaning.
   4. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be cleaned to the Architect's acceptance.

B. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

3.5 PROTECTION

A. Protect installed door frames in place from soiling, deterioration, and damage until Substantial Completion.

B. Do not store anything adjacent to or against installed door frames unless they are protected from damage, as accepted in writing by the manufacturer's representative. Do not use installed door frames as work surfaces.

C. Remove protection when it's no longer needed and before Substantial Completion.

END OF SECTION

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SECTION 08 13 13 – STANDARD HOLLOW METAL DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Standard hollow metal doors.
   2. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

B. Related Requirements:
   1. Section 08 71 00 for door hardware.

1.2 REFERENCES

A. Abbreviations and Acronyms:
   1. BMT: Base Metal Thickness.
   2. DHI: Door Hardware Institute.
   3. HM: Hollow Metal.
   4. MSG: Manufacturer's Standard Gage.
   5. SDI: Steel Door Institute.

B. Definitions:
   1. Manufacturer: Means the door manufacturer, unless otherwise indicated.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate building opening tolerances with door manufacturing and erection tolerances.
   2. Coordinate hardware preparations, handing, and reinforcement requirements and locations with the Drawings, door schedule, and selected hardware sets.
   3. Coordinate door hardware finishes with other door hardware finishes.

1.4 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).

1. Product Data: Submit manufacturer's product data, specifications, typical installation details, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs) and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
2. Door Schedule: Submit schedule showing opening identification symbols and door and frame types and sizes, including thickness, swing, fire-resistance rating label requirements, undercuts, and finishes. Use the same reference numbers for openings and details as the Drawings.
3. Shop Drawings: Include project-specific dimensioned details drawn to scale showing conditions not detailed on the product data; or that are detailed, but not in a manner specific to the project. Cross-reference details to door schedule.

B. Informational Submittals: Submit the following for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
1. Manufacturer's Instructions: Submit manufacturer-prepared published instructions for proper installation of furnished doors.
a. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.
b. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.
2. Qualification Statements: Submit written descriptions confirming experience specified in QUALITY ASSURANCE article below.

1.5 QUALITY ASSURANCE

A. Source Limitations:
1. Doors must be obtained through one source from the same manufacturer (to ensure compatibility, regulatory conformance, and a warrantable installation).
a. Certain items may be obtained from more than one manufacturer, but only when used for separate installations.
b. Items provided for each different installation must be obtained from the same source and manufacturer.
2. Provide secondary materials, components, accessories and other items from sources required, recommended, or accepted by the primary manufacturer for actual in-service conditions applicable to the project.

B. Regulatory Requirements:
1. Fire-Protection Rating: Within fire-resistance rated assemblies, provide fire-protection-rated doors conforming to NFPA 80, "*Standard for Fire Doors and Other Opening Protectives*" and tested in conformance with NFPA 252, "*Standard Methods of Fire Tests of Door Assemblies*" and UL 10B, "*Standard for Fire Tests of Door Assemblies*"**;** or UL 10C, "*Standard for Positive Pressure Fire Tests of Door Assemblies*"

for doors at atmospheric (neutral) pressure. A label or listing mark indicating the fire-protection rating must be permanently affixed at the factory in a location such that the label remains visible after the door is installed and must include UL "S" and "Positive Pressure Test" listings.

2. Temperature Rise Rating: At vertical exit enclosures and exit passageways, provide doors with a maximum transmitted temperature end point of not more than 450 deg F above ambient after 30 minutes of standard fire-test exposure.
3. Smoke-Control Door Assemblies: Provide doors conforming to the requirements of with NFPA 80, "*Standard for Fire Doors and Other Opening Protectives*" and tested in conformance with NFPA 105, "*Standard for Smoke Door Assemblies and Other Opening Protectives*" or UL 1784, "*Standard for Air Leakage Tests of Door Assemblies*".

C. Quality Standard Requirements:
1. Manufacturing Tolerances: Comply with the requirements of ANSI/SDI publication ANSI/SDI A250.8, "*Recommended Specifications for Standard Steel Doors and Frames"*.
2. Hardware Preparations and Reinforcement: Comply with the requirements of ANSI/SDI A250.6, "*Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames*" with reinforcing plates fabricated from the same material as door face sheets.
3. Door Hardware Installation Standards: Install door hardware in conformance with ANSI/DHI A115-IG, "*Installation Guide for Doors and Hardware*".

D. Qualifications:
1. Manufacturer: Company or individuals must have at least 10 years' experience manufacturing doors installed on at least 200 previous projects similar to this project in size, material, design, and complexity. Manufacturer must be a current member of SDI.
2. Installer: Company or individuals must have at least 5 years' experience installing doors for at least 30 previous projects similar to this project in size, material, design, and complexity. Installer must be a current member of SDI.
3. Supervisors: Individuals must have at least 7 years' experience installing doors for at least 30 previous projects similar to this project in size, material, design, and complexity, including at least 2 years' supervisory experience directing and leading door installers.

1.6 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
2. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items as shipped, upright, and indoors within dry, well-ventilated, broom-cleaned, and partially- or permanently-enclosed storage areas.

C. Damaged Item Replacement: Promptly remove and replace items that are deteriorated, damaged, or defective with undamaged new items that do not exhibit deterioration, damage, or defects.

D. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide products manufactured by one of the following, or equal.
   1. Allegion PLC.
   2. ASSA ABLOY.
   3. Door Components, Inc.
   4. MPI Custom Steel Doors and Frames.
   5. Republic Doors and Frames.

2.2 STANDARD HOLLOW METAL DOORS

A. Description: Commercial full flush and seamless steel-stiffened doors.

B. Products: “Steelcraft” doors manufactured by Allegion, or equal.
   1. Standard Duty Doors: “SL20” doors, or equal.
   2. Heavy Duty Doors: “BW18” doors, or equal.
   3. Extra Heavy Duty Doors: “BW16” doors, or equal.
   4. Maximum Duty Doors: “BW14” doors, or equal.
   5. Temperature Rise Rated Doors: “T-14” doors, or equal.

C. Requisite Properties:
   1. Construction: Provide the following, conforming to SDI 108.
      a. Main Entrance and Exit Doors: Level 4 (maximum-duty), Model 2 (seamless with welded edge construction).
      b. Stairwell Doors: Level 3 (extra heavy-duy), Model 2 (seamless with welded edge construction).
      c. Toilet Room Doors: Level 3 (extra heavy-duy), Model 2 (seamless with welded edge construction).
      d. Mechanical, Storage, and Utility Doors: Level 3 (extra heavy-duty), Model 2 (seamless with welded edge construction).
      e. Operating and Exam Room Doors: Level 3 (extra heavy-duty), Model 2 (seamless with welded edge construction).

f. Patient Room Doors: Level 3 (extra heavy-duty), Model 2 (seamless with welded edge construction).
g. Cafeteria Doors: Level 3 (extra heavy-duty), Model 2 (seamless with welded edge construction).
h. Individual Office Doors: Level 1 (standard-duty), Model 1 (full flush).
i. Bathroom Doors: Level 1 (standard-duty), Model 1 (full flush).
j. Closet Doors: Level 1 (standard-duty), Model 1 (full flush).

2. Types: SDI 106, Type F (flush), Type G (half glass), Type V (vision light), Type FG (full glass), Type N (narrow light), Type L (louvered), as indicated on the Drawings.
3. Thickness: 1-3/4 inches.
4. Face Sheets:
   a. Exterior Doors: Fabricate from at least 0.0747-inch BMT (MSG 14) galvannealed steel sheet. (maximum duty)
   b. Interior Doors at Wet Locations, including Shower and Toilet Rooms: Fabricate from at least 0.0747-inch BMT (MSG 14) galvannealed steel sheet. (maximum duty)
   c. Interior Doors Located Elsewhere: Fabricate from at least 0.0598-inch BMT (MSG 16) CRS. (extra heavy duty)
   d. Level 1 (standard duty): 0.0359-inch BMT (MSG 20)
   e. Level 2 (heavy-duty): 0.0478-inch BMT (MSG 18)
   f. Level 3 (extra heavy-duty): 0.0598-inch BMT (MSG 16)
   g. Level 4 (maximum-duty): 0.0747-inch BMT (MSG 14)
5. Core Construction:
   a. Exterior Insulated Doors: Maximum thermal transmittance (U-factor) value of not more than 0.50 BTU per hour per square foot per deg. F, when tested in conformance with ASTM C 1363.
   b. Fire-Resistance Rated and Other Doors: Manufacturer’s standard core necessary to meet indicated fire-resistance and temperature-rise ratings.
6. Vertical Edges: Manufacturer's standard edge with mechanical edge seam welded and finished before priming.
7. Top and Bottom Edges: Close edges with flush or inverted channels or end closures fabricated from same material as face sheets, but not less than at least 0.0747-inch BMT (MSG 14). Provide screw-on caps at exterior doors.
8. Minimum Hardware Reinforcement: Fabricate reinforcing from the same material as door in conformance with the following. Reinforcement must be offset to allow faces of mortised hardware devices to be installed flush with door surfaces.
   a. Hinges: At least 0.1094-inch BMT (MSG 12) continuous stile extruded and tapped to at least 0.1875-inch BMT (MSG 07) reinforcement, unless another thickness and size are required by the by the hardware manufacturer based on actual in-service conditions applicable to the project.
   b. Lock Front, Strike, and Flushbolt Reinforcement: At least 0.1094-inch BMT (MSG 12) by sizes required by the hardware manufacturer, unless another thickness is required by the by the hardware manufacturer based on actual in-service conditions applicable to the project.

c. Lock Reinforcement: At least 0.0625-inch BMT (MSG 16) by size as required by lock manufacturer, unless another thickness is required by the by the hardware manufacturer based on actual in-service conditions applicable to the project.
d. Closer Reinforcement: At least 0.0625-inch BMT (MSG 16) one-piece channel by size as required by the closer manufacturer, unless another thickness is required by the by the hardware manufacturer based on actual in-service conditions applicable to the project.
e. Exit Device Reinforcement: 0.0781-inch BMT (MSG 14) by 18 inches high by 3-3/16 inches wide, unless another thickness and size are required by the by the hardware manufacturer based on actual in-service conditions applicable to the project.
f. Other Hardware Reinforcement: Supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.
g. Hardware manufacturers' recommended reinforcement units may be used in lieu of specified reinforcement.

9. Electrical Device Requirements: Make provisions for installation of electrified hardware and door electrical devices, and arrange so that wiring is readily installed, removed, and replaced.
   a. Provide cutouts and reinforcement required for installation of devices.
   b. Provide metal conduits or raceways to accommodate wiring between devices. (e.g., from electric hinge to other electric door hardware)

2.3 ACCESSORIES

A. Filler: Material conforming to the requirements of SDI publication SDI 100, "*Specifications for Standard Steel Doors and Frames*". Use UL-listed materials in doors scheduled to have a fire-resistance rating.

B. Vision Lights: "Vision Lite Kits" manufactured by TRUDOOR, LLC, or equal.
   1. Frames: At least at least 0.0359-inch BMT (MSG 20) uncoated steel sheet, with mitered and welded corners and countersunk mounting holes.
   2. Finish: Manufacturer's standard powder coat finish.
   3. Frame Color: Indicated on the Drawings.

C. Door Louvers:
   1. Products: Provide the following manufactured by USA Fire Door LLC, or equal.
      a. Standard Door Louvers: "800 Series", or equal, 0.0478-inch BMT (MSG 18) uncoated steel louver door inserts.
      b. Fire-Rated Door Louvers: "1900 Series", or equal, 0.0478-inch BMT (MSG 18) uncoated steel louver door inserts.
   2. Requisite Properties:
      a. Blades: Inverted Y or Z blades.
      b. Minimum Free Area: Between 40 and 50 percent.

c. Finish: Manufacturer's standard powder coat finish; custom colors selected by the Architect.

D. Fastenings: Provide backings, inserts, loose connection hardware, fasteners, anchors, attachments, connectors, and other items supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

E. Other Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

2.4 MATERIALS

A. Uncoated Carbon Steel Sheet:
   1. Door Material: Finished CRS coil, sheet, and strip conforming to ASTM A 1008, CS Type B (commercial steel), exposed, temper rolled, regular matte surface finish (40 to 59 AA), and oiled (sheet must be thoroughly cleaned to remove the oil prior to painting).
   2. Hardware Reinforcements: HRS coil, sheet, and strip conforming to ASTM A 1011, CS Type B (commercial steel), as-rolled surface finish, with cut edges.

B. Zinc-Iron Alloy Coated (Galvannealed) Steel Sheet: ASTM A 653, CS Type B (commercial steel), with equal coating weight on each surface.
   1. Coating Designation: Provide at least a A60 (galvannealed) minimum coating designation.
   2. Surface Finish: Non-spangled matte finish.
   3. Surface Treatment: Provide mill phosphate surface treatment. (provides enhanced lubricating characteristics)

2.5 FINISHES

A. Uncoated Steel HM Frames: Provide shop-applied phosphate (paint-grip) pre-treatment and baked on rust inhibitive primer to all 6 door surfaces. Primer must be compatible with either field-applied paint or field-applied coating systems specified in Division 09, as applicable.

B. Zinc Coated and Zinc-Iron Alloy Coated Steel and Stainless Steel HM Frames: Provide shop-applied bonderized pre-treatment. (not prime painted)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification: Verify in-place supporting and adjacent construction conforms to the manufacturer's requirements or recommendations and satisfies all other conditions that might affect the quality of installation or the durability, appearance, or performance of installed and adjacent items.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.
   2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 INSTALLATION

A. General Requirements:
   1. Install doors in conformance with the quality standards publications using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
   2. Set items true to line, to required levels and lines, and plumb, level, and square, without warp or rack, with flush well-fitted joints, and in alignment with adjacent construction
   3. Perform drilling and fitting as required or necessary for an accurate fit and complete installation.
   4. Installed doors must be warrantable. Do not install, correct, or replace doors in a manner that results in any warranty or guarantee becoming void.

B. Interface with Adjacent Items: Provide materials, components, and accessories normally furnished or necessary to securely attach doors to supporting construction.

C. Installation Tolerances:
   1. Fire-Rated Doors: Install doors with clearances in conforming to NFPA 80.
   2. Smoke- Control Doors: Install doors with clearances in conforming to NFPA 105.
   3. Other Doors: Install doors within the following clearance variations.
      a. Jambs and Head: 1/8-inch plus or minus 1/16 inch.
      b. Between Edges of Pairs of Doors: 1/8-inch plus or minus 1/16-inch.
      c. Between Bottom of Door and Top of Threshold: Maximum 1/4-inch.

d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 1/4-inch.

3.3 ADJUSTING

A. Verify smooth and quiet door and hardware operation.

B. Lubricate and adjust operating parts and hardware to function properly, free from warp, twist, binding, and distortion. Confirm latches and locks engage securely without forcing or binding.

C. Replace items that do not operate freely in a safe and reliable manner.

3.4 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
   1. written descriptions of non-conforming, damaged, and defective work;
   2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
   3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.5 CLEANING

A. Cleaning Work: Clean all visible door surfaces in a manner that does not result in any warranty or guarantee becoming void.
   1. Use cleaning materials, equipment, and accessories supplied, and means, methods, techniques, and procedures required, recommended, or accepted by the manufacturer.
   2. Do not use cleaning materials or procedures known to change, or that might change, the appearance of exposed finishes or adjacent surfaces; or cause deterioration or damage to exposed finishes or adjacent surfaces.
   3. Protect adjacent surfaces not being cleaned from staining, deterioration, damage, or other detrimental effects caused by cleaning.

4. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be cleaned to the Architect's acceptance.

B. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

3.6 PROTECTION

A. Protect installed doors in place from soiling, deterioration, and damage until Substantial Completion.

B. Do not store anything adjacent to or against installed doors unless they are protected from damage, as accepted in writing by the manufacturer's representative. Do not use installed doors as work surfaces.

C. Remove protection when it's no longer needed and before Substantial Completion.

END OF SECTION

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SECTION 08 14 24 – PLASTIC LAMINATE-FACED WOOD DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. High pressure plastic laminate (HPL)-faced flush wood doors.
   2. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

B. Related Requirements:
   1. Section 08 71 00 for door hardware.

1.2 REFERENCES

A. Abbreviations and Acronyms:
   1. DHI: Door Hardware Institute.
   2. WDMA: Wood Door Manufacturers Association.

B. Definitions:
   1. Manufacturer: Means the door manufacturer, unless otherwise indicated.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate building opening tolerances with door manufacturing and erection tolerances.
   2. Coordinate hardware preparations, handing, and reinforcement requirements and locations with the Drawings, door schedule, and selected hardware sets.
   3. Coordinate door hardware finishes with other door hardware finishes.

1.4 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data:
      a. Submit manufacturer’s product data, specifications, typical installation details, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs) and safety data sheets

(SDSs), both of which are returned to the Contractor without review or responsive action.

b. Submit sample warranties with warranty periods, terms, conditions, exclusions, and remedies explicitly defined for each warranty, including clear warranty period start dates. (e.g., date of manufacture, purchase, installation, Beneficial Occupancy, Substantial Completion, Final Completion, etc.)

2. Door Schedule: Submit schedule showing opening identification symbols and door and frame types and sizes, including thickness, swing, fire-resistance rating label requirements, undercuts, and finishes. Use the same reference numbers for openings and details as the Drawings.
3. Shop Drawings: Include project-specific dimensioned details drawn to scale showing conditions not detailed on the product data; or that are detailed, but not in a manner specific to the project. Cross-reference details to door schedule.
4. Samples: Submit at least 8-inch square representative samples of each door color, finish, and variety.

B. Informational Submittals: Submit the following for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).

1. Manufacturer's Instructions: Submit manufacturer-prepared published instructions for proper installation of furnished doors.
   a. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.
   b. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.
2. Qualification Statements: Submit written descriptions confirming experience specified in QUALITY ASSURANCE article below.

C. Closeout Submittals:

1. Maintenance Data: Submit copies of manufacturer's instructions and other requirements and recommendations for door maintenance, cleaning, and repair to the Architect as a condition of project closeout.
2. Warranty Documentation: Submit final warranties signed by the manufacturer's representative with complete terms indicated for all warranties covering items furnished or installed under this specification section.

1.5 QUALITY ASSURANCE

A. Source Limitations:

1. Doors must be obtained through one source from the same manufacturer (to ensure compatibility, regulatory conformance, and a warrantable installation).
   a. Certain items may be obtained from more than one manufacturer, but only when used for separate installations.

b. Items provided for each different installation must be obtained from the same source and manufacturer.

2. Provide secondary materials, components, accessories and other items from sources required, recommended, or accepted by the primary manufacturer for actual in-service conditions applicable to the project.

B. Regulatory Requirements:

1. Fire-Protection Rating: Within fire-resistance rated assemblies, provide fire-protection-rated doors conforming to NFPA 80, "*Standard for Fire Doors and Other Opening Protectives*" and tested in conformance with NFPA 252, "*Standard Methods of Fire Tests of Door Assemblies*" and UL 10B, "*Standard for Fire Tests of Door Assemblies*"**;** or UL 10C, "*Standard for Positive Pressure Fire Tests of Door Assemblies*" for doors at atmospheric (neutral) pressure. A label or listing mark indicating the fire-protection rating must be permanently affixed at the factory in a location such that the label remains visible after the door is installed and must include UL "S" and "Positive Pressure Test" listings.

2. Smoke-Control Door Assemblies: Provide doors conforming to the requirements of with NFPA 80, "*Standard for Fire Doors and Other Opening Protectives*" and tested in conformance with NFPA 105, "*Standard for Smoke Door Assemblies and Other Opening Protectives*" or UL 1784, "*Standard for Air Leakage Tests of Door Assemblies*".

C. Quality Standard Requirements:

1. Product Standard: Comply with the requirements Window & Door Manufacturers Association publication ANSI/WDMA I.S.1-A, "*Industry Standard for Interior Architectural Wood Flush Doors"*.

2. Door Hardware Installation Standards: Install door hardware in conformance with ANSI/DHI A115-IG, "*Installation Guide for Doors and Hardware*".

D. Qualifications:

1. Manufacturer: Company or individuals must have at least 10 years' experience manufacturing doors installed on at least 200 previous projects similar to this project in size, material, design, and complexity. Manufacturer must be a current member of WDMA.

2. Installer: Company or individuals must have at least 5 years' experience installing doors for at least 30 previous projects similar to this project in size, material, design, and complexity.

3. Supervisors: Individuals must have at least 7 years' experience installing doors for at least 30 previous projects similar to this project in size, material, design, and complexity, including at least 2 years' supervisory experience directing and leading door installers.

1.6 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.

1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
2. Reject items that are not transported, delivered, or protected in conformance with manufacturer-recommended transport, delivery, and receiving requirements.
3. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items indoors as shipped, upright in their original packaging or containers, within dry, well-ventilated, broom-cleaned and enclosed storage areas.
1. Furnish adequate dunnage and bracing during storage.
2. Prevent stored items from contacting the floor, from soiling and staining, and from deterioration and damage.
3. Do not leave items uncovered where they might be exposed to weather or become wet; or exposed to heat or sudden changes in temperature or relative humidity; or other sources of deterioration and damage, including dust and other airborne contaminants.

C. Handling: Handle items in conformance with manufacturer's instructions and other requirements and recommendations, and in a manner that that prevents damage. Avoid damage to packaging and containers.

D. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective doors with undamaged new doors that do not exhibit deterioration, damage, or defects.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

1.7 WARRANTY

A. Manufacturer Warranty: Furnish to the Owner a written manufacturer warranty for products, components, and accessories against all patent and latent defects, and incipient and catastrophic failure for 5 years.

PART 2 - PRODUCTS

2.1 PLASTIC LAMINATE-FACED DOORS

A. Description: Flush wood doors conforming to WDMA I.S.1-A Performance Grade Heavy Duty.

B. Restrictions: Doors manufactured with adhesives and composite wood products containing urea formaldehyde are prohibited.

C. Product: "Marquis Series" doors manufactured by Marshfield DoorSystems, Inc., or equal.

D. Requisite Properties:
   1. Type: Solid Core
   2. Grade: Custom.
   3. Thickness: 1-3/4 inches.
   4. Construction: 5-ply.
   5. Core: Manufacturer's standard wood-based particleboard, structural composite lumber, agrifiber, or fire-resistant mineral core.
   6. Edge Construction: Structural composite lumber or hardwood lumber stiles and rails securely bonded to core components and machine calibrated before veneering, with laminate vertical edges and laminate top and bottom rails matching laminate faces.
   7. Meeting Edge: Beveled.
   8. Hardware Blocking:
      a. 5-by-18-inch lock blocks at both stiles.
      b. 5-inch top- and bottom-rail blocking.
      c. 2-1/2-inch mid-rail blocking.
   9. Horizontal Surfaces: Structural composite lumber.
   10. Openings: Cut and trim through-door openings in factory.
      a. Light Openings: Trim openings with materials and profiles indicated.
      b. Glazing: Factory install glazing.
      c. Louvers: Factory install louvers in prepared openings.

2.2 PLASTIC LAMINATE FACING

A. Description: General purpose type HPDL conforming to NEMA publication "*NEMA Standards Publication LD-3*" requirements for Grade SGF (flame-retardant) for fire-rated doors; Grade HGS (standard) for other doors. Provide laminate vertical edges and laminate top and bottom rails matching laminate faces.

B. Manufacturers: Provide products manufactured by one of the following, or equal.
   1. Formica Corp.
   2. Lamin-Art, Inc.
   3. Panolam Industries International, Inc.
   4. Wilsonart LLC.

C. Products: Selected by the Architect, or equal.

2.3 ACCESSORIES

A. Vision Lights: "Vision Lite Kits" manufactured by TRUDOOR, LLC, or equal.
   1. Frames: At least at least 0.0359-inch BMT (MSG 20) uncoated steel sheet, with mitered and welded corners and countersunk mounting holes.
   2. Finish: Manufacturer's standard powder coat finish.

3. Frame Color: Indicated on the Drawings.

B. Door Louvers:
   1. Products: Provide the following manufactured by USA Fire Door LLC, or equal.
      a. Standard Door Louvers: “800 Series”, or equal, 0.0478-inch BMT (MSG 18) uncoated steel louver door inserts.
      b. Fire-Rated Door Louvers: “1900 Series”, or equal, 0.0478-inch BMT (MSG 18) uncoated steel louver door inserts.
   2. Requisite Properties:
      a. Blades: Inverted Y or Z blades.
      b. Minimum Free Area: Between 40 and 50 percent.
      c. Finish: Manufacturer’s standard powder coat finish; custom colors selected by the Architect.

C. Electrical Device Requirements: Make provisions for installation of electrified hardware and door electrical devices, and arrange so that wiring is readily installed, removed, and replaced.
   1. Provide cutouts and reinforcement required for installation of devices.
   2. Provide metal conduits or raceways to accommodate wiring between devices. (e.g., from electric hinge to other electric door hardware)

D. Fastenings: Provide backings, inserts, loose connection hardware, fasteners, anchors, attachments, connectors, and other items supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

E. Other Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification: Verify in-place supporting and adjacent construction conforms to the manufacturer’s requirements or recommendations and satisfies all other conditions that might affect the quality of installation or the durability, appearance, or performance of installed and adjacent items.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the manufacturer’s instructions and other requirements and recommendations.

2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 INSTALLATION

A. General Requirements:
   1. Install doors in conformance with the quality standards publications using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
   2. Set items true to line, to required levels and lines, and plumb, level, and square, without warp or rack, with flush well-fitted joints, and in alignment with adjacent construction
   3. Perform drilling and fitting as required or necessary for an accurate fit and complete installation.
   4. Installed doors must be warrantable. Do not install, correct, or replace doors in a manner that results in any warranty or guarantee becoming void.

B. Special Techniques:
   1. Factory-Fitted Doors: Align in frames for uniform clearance at each edge. Hang doors to operate freely for their entire travel, but not loosely, without sticking or hinge binding, with hardware adjusted and functioning properly.
   2. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

C. Interface with Adjacent Items: Provide materials, components, and accessories normally furnished or necessary to securely attach doors to supporting construction.

D. Installation Tolerances:
   1. Fire-Rated Doors: Install doors with clearances in conforming to NFPA 80.
   2. Smoke- Control Doors: Install doors with clearances in conforming to NFPA 105.
   3. Other Doors: Install doors within the following clearance variations.
      a. Jambs and Head: 1/8-inch plus or minus 1/16 inch.
      b. Between Edges of Pairs of Doors: 1/8-inch plus or minus 1/16-inch.
      c. Between Bottom of Door and Top of Threshold: Maximum 1/4-inch.
      d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 1/4-inch.

3.3 ADJUSTING

A. Verify smooth and quiet door and hardware operation.

B. Lubricate and adjust operating parts and hardware to function properly, free from warp, twist, binding, and distortion. Confirm latches and locks engage securely without forcing or binding.

C. Rehang or replace doors that do not operate freely in a safe and reliable manner.

3.4 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
   1. written descriptions of non-conforming, damaged, and defective work;
   2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
   3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.5 CLEANING

A. Cleaning Work: Clean all visible door surfaces in a manner that does not result in any warranty or guarantee becoming void.
   1. Use cleaning materials, equipment, and accessories supplied, and means, methods, techniques, and procedures required, recommended, or accepted by the manufacturer.
   2. Do not use cleaning materials or procedures known to change, or that might change, the appearance of exposed finishes or adjacent surfaces; or cause deterioration or damage to exposed finishes or adjacent surfaces.
   3. Protect adjacent surfaces not being cleaned from staining, deterioration, damage, or other detrimental effects caused by cleaning.
   4. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be cleaned to the Architect's acceptance.

B. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

3.6 PROTECTION

A. Protect installed doors in place from soiling, deterioration, and damage until Substantial Completion.

B. Do not store anything adjacent to or against installed doors unless they are protected from damage, as accepted in writing by the manufacturer's representative. Do not use installed doors as work surfaces.

C. Remove protection when it's no longer needed and before Substantial Completion.

END OF SECTION

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SECTION 08 17 13 – INTEGRATED DOOR ASSEMBLIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Materials Included: Door assemblies including frame, door, exit device, hinge, magnetic hold open, door closer, and all hardware required for a labeled assembly opening.

1.2 RELATED SECTIONS & COORDINATION

A. Summary of Work: Division 01, applicable Sections, including but not limited to:
   1. Section 01 74 19 "Construction and Demolition Waste Management and Disposal."
   2. Section 01 81 13 "Sustainable Design Requirements" for LEED v4 requirements.

B. Masonry: Division 04, applicable Sections.

C. Carpentry: Division 06, applicable Sections (Section 06 10 00 Rough Carpentry).

D. Perimeter Sealants and Insulation: Division 07, applicable Sections.

E. Division 8, applicable Sections including, but not limited to, Hollow Metal Doors and/or Frames; 08 71 00 “Door Hardware” and 08 71 13 “Automatic Door Operators”.

F. Divisions 26 through 28: Electrical rough in, wiring and connectors for electrified hardware including, but not limited to:
   1. Wire and connectivity from ceiling through frame to electrified hardware devices including non-08 17 13 task of providing wiring inside of doors.
   2. Section 08 71 13 “Automatic Door Operators”
   3. FLS (Fire/Life Safety) Connectivity Scope: At fire & smoke rated opening, in event of fire/smoke, electrified strikes and auto operators to become non-electrified (drop power for doors can close, positive latch & to be only manually operated). Electrified fail-secure levers do not require to be coordinated with FLS system.

1.3 REFERENCES

A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only. Refer to Division 01 for definitions, acronyms, and abbreviations.

B. Standards, manuals, and codes refer to the latest edition of such standards, manuals, and codes in effect as of the date of issue of this Project Manual, unless indicated otherwise in CBC.

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C. Referenced Standards:

1.	CBC	– 2022 California Building Code.
2.	ADA	– Americans with Disabilities Act - 2010 Standards for Accessible Design.
3.	ANSI A156 Series	– Builders Hardware Manufacturers Association (BHMA) Standards Set.
4.	ANSI/SDI A250.6	– Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames.
5.	ANSI/SDI A250.8	– Standard Steel Doors and Frames.
6.	ASTM A653/A653M	– Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
7.	ASTM A1008/A1008M	– Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
8.	ASTM A1011/A1011M	– Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
9.	ASTM C578	– Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
10.	ANSI/NAAMM HMMA 861	– Guide Specifications for Commercial Hollow Metal Doors and Frames.
11.	NAAMM HMMA 840	– Guide Specification for Installation and Storage of Hollow Metal Doors and Frames.
12.	NFPA 80	– Standard for Fire Doors and Other Opening Protectives.
13.	NFPA 101	– Life Safety Code.
14.	NFPA 105	– Standard for the Installation of Smoke Door Assemblies and Other Opening Protectives.
15.	NFPA 252	– Standard Methods of Fire Tests of Door Assemblies.
16.	NFPA 257	– Standard on Fire Test for Window and Glass Block Assemblies.
17.	NFRC 400	– Procedure for Determining Fenestration Product Air Leakage.
18.	UL 9	– Standard for Safety Fire Tests of Window Assemblies.
19.	UL 10B	– Fire Tests of Door Assemblies.
20.	UL 10C	– Positive Pressure Fire Tests of Door Assemblies.
21.	UL 1784	– Air Leakage Tests for Door Assemblies.

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1.4 COORDINATION:

A. The Hardware Set specified in in this Section and Section 08 71 00 “Door Hardware” - Part 3 are intended to establish type and design standard when used together with the requirements of this Section, Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections. Examine Contract Documents and furnish proper hardware for door openings. Refer to specifications for clarification and detailed requirements and provide products and services in specifications even if not written in Hardware Set.

B. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

C. Convene coordination meeting between all opening vendors and installers at least two weeks prior to purchasing doors, frames, door hardware, and electrical devices required for complete systems.
   1. Required attendance includes, but is not limited to, the following: Contractor, hardware supplier and/or installer, door supplier and/or installer, frame supplier and/or installer and electrical contractor.
   2. Contractor shall be responsible for verifying that the door hardware accepted for installation is compatible for use with the doors and door-frames.
   3. Vendor and/or installer (coordinate accordingly) is not responsible for electrical-power (see electrical drawings) or FLS (fire/life safety) connectivity to above frame or back-of-house power supply (back-of-house meaning remote low voltage power). FLS connectivity only required for fire or smoke rated opening in particular functions shall meet Code as scheduled.

1.5 SUBMITTALS

A. General:
   1. Submit in accordance with Division 01.

B. LEED Submittals:
   1. The Owner requires the Contractor to implement practices and procedures to meet the project’s environmental performance goals, which include achieving LEED v4 Certification. Refer to Section 01 81 13 "Sustainable Design Requirements" for the Project’s target certification level and specific LEED requirements. The Contractor shall ensure that the requirements related to the Project’s sustainability design goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project’s sustainability goals and LEED certification.
   2. EPD/LCA Documentation: Provide a publicly available Environmental Product Declaration in conformance with standards listed and described in Section 01 81 13

"Sustainable Design Requirements."

3. Manufacturer Take-back Documentation: Provide documentation of the manufacturer's take-back program as defined in Section 01 81 13 "Sustainable Design Requirements."
4. Regional Sourcing Documentation: Provide a product data sheet or manufacturer affidavit demonstrating regional sourcing as defined in Section 01 81 13 "Sustainable Design Requirements."
5. Recycled Content Documentation: Provide a product data sheet or manufacturer affidavit noting the pre-consumer (post-industrial) and post-consumer recycled content value of the product or product components in accordance with requirements described in Section 01 81 13 "Sustainable Design Requirements."

C. Pre-Hardware Schedule:
   1. Report all prevailing conditions that will adversely affect satisfactory execution of work.

D. Shop Drawings: Include illustrations and schedule of finish hardware, door and frame size, type, material, fire ratings, construction, finishing, anchoring, glazing, accessories, and preparation for installing hardware.
   1. Method of attachment of frames to structure shall be reviewed by Architect for acceptance or rejection.
   2. Details of conduit and preparations for power, signal, and control systems.

E. Templates: Furnish hardware templates to fabricator of frames to be factory prepared for installation of hardware. Refer to groups/sets specified in in this Section, Section 08 71 13 “Automatic Door Operators” and Section 08 71 00 “Door Hardware” - Part 3.

F. Submit product data for type of metal primer proposed for use.

G. Submit a detailed hardware schedule according to the following:
   1. Submit hard copies of hardware schedule (number of copies per Division 01) as well as submit editable, PDF files via electronic email of ftp site process in vertical format as illustrated by the Sequence of Format for the Hardware Schedule as published by the Door and Hardware Institute. Schedules which do not comply will be returned for correction before checking. Horizontal-type schedules will be returned for correction before checking.
   2. Hardware schedule shall clearly indicate each hardware group specified and manufacturer of each item proposed.
   3. Provide two copies of illustrations from manufacturer’s catalogs and data in brochure form.

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4. Wiring Information: Provide manufacturers' wiring information including manufacturers' door elevation diagrams for electrified hardware based on Door Hardware Institute (DHI) core class "Electrified Architectural Hardware" DHI class #COR133. Openings where only magnetic hold-opens or door position switches are specified do not require wiring information. Provide information with hardware schedule submittal for review. Provide detailed wiring diagrams with hardware delivery to jobsite.
5. Review of schedules does not relieve the Contractor of providing all hardware required for the Work, whether or not such hardware was inadvertently omitted from Submittal.

H. Hardware Templates:
1. Provide listing of manufacturer's template numbers for each item of hardware in hardware schedule.
2. Submit templates and "Reviewed Hardware Schedule" to door and frame supplier and others as applicable to enable proper and accurate sizing and locations of cutouts and reinforcing.

I. Hardware Installation Instructions:
1. Provide manufacturer's written installation and adjustment instructions for finish hardware.
2. Send installation instructions to site with hardware.

J. Hardware Closeout Submittals:
1. Operating and maintenance manuals: Submit three sets containing the following:
a. Complete information in care, maintenance, and adjustment, data on repair and replacement parts, and information on preservation of finishes.
b. Catalog pages for each product.
c. Name, address, and phone number of local representative for each manufacturer.
d. Parts list for each product.
e. Copy of final accepted hardware schedule, edited to reflect "As installed".

1.6 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings.

B. Standard Hollow Metal Work: Hollow metal work fabricated according to ANSI/SDI A250.8.

C. Custom Hollow Metal Work: Hollow metal work fabricated according to ANSI/NAAMM-HMMA 861.

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1.7 QUALITY ASSURANCE

A. Provide doors and frames complying with ANSI A250.8, [ANSI/NAAMM-HMMA 861,] and as specified herein.

1.8 REGULATORY REQUIREMENTS

A. Fire-Rated Doors and Frames: Provide doors and frames complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at [positive pressure] according to [NFPA 252] [or UL 10C] [UL 10B].
   1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
   2. Temperature-Rise Limit: [Where indicated] [At vertical exit enclosures and exit passageways], provide doors that have a maximum transmitted temperature end point of not more than 450 degrees F above ambient after thirty minutes of standard fire-test exposure.

B. Testing of Fire-Rated Door and Frame Assembly: Conform to applicable requirements of CBC.

C. Doors and Frames for Smoke-Control Door Assemblies: Comply with applicable requirements of [NFPA 105 or UL 1784].

D. Fire-Rated Door and Frame Labels: All fire rated doors and frames shall have metal labels (including “S” labels) permanently fastened to the jamb indicating the fire rating and Testing Agency name.
   1. Do not apply primer or paint over fire rating labels.

E. Fire-Rated, Borrowed-Light Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9. Label each individual glazed lite.

F. Security Door [and Window] Assemblies: Meeting Level 3, UL 752 requirements.

1.9 DELIVERY, STORAGE AND HANDLING

A. Deliver all materials under protective cover and store in upright position within a dry enclosed space in a manner that will prevent rust and damage. Do not create a humidity chamber by using a plastic or canvas shelter that is not adequately vented.

B. Deliver fully-welded frames with two removable spreader bars across bottom of door frames, tack welded to jambs and mullions.

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1.10 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.11 WARRANTY

A. Comply with provisions of Division 01

B. Unless otherwise specified, furnish to Owner a written manufacturer's 2 year extended guarantee for automatic door operators against defects in materials and workmanship.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers and Products:
   1. "Syntegra Systems / Integrated Door Assemblies" manufactured by Syntegra Manufacturing (http://www.syntegrausa.com/)

2.2 HARDWARE TEMPLATE

A. Make templates for hardware to be applied to metal or to pre-finished doors.

B. Hinge templates shall conform to ANSI A156.7.

C. Promptly furnish template information or templates to door and frame manufacturers.

D. Coordinate hardware items to prevent interference with each other.

2.3 FIRE RATED DOORS AND EXIT DOORS

A. Provide all hardware necessary to meet the requirements of CBC for fire doors and exit doors, as well as to other requirements specified, even if such hardware is not specifically mentioned under Article "Hardware Schedule" of this Section.

2.4 DOOR & FRAME FINISHES

A. Finish: BHMA 630

B. After fabrication, thoroughly clean surfaces of mill scale, rust, oil, grease, dirt, and other foreign matter, and chemically treat with phosphate compound to assure maximum paint adhesion.

C. Primers shall comply with ANSI A224.1, "Test Procedure and Acceptance Criteria for Primed Painted Steel Surfaces."

2.5 BHMA HARDWARE FINISHES

A. Where Hardware Set have different information, refer to the following for clarification. Provide Hardware Set devices/finishes, along with added finishes below, as indicated on drawings and detailed requirements for each type of device:
   1. Typical BHMA finish designation references:
      a. BHMA 630 – satin stainless steel.
      b. BHMA 652 – satin or dull chromium plated steel.
      c. BHMA 626 – satin chromium plated brass or bronze.
      d. BHMA 628 – satin or dull aluminum, clear anodized (uncoated).

2.6 SCREWS, BOLTS, AND FASTENING DEVICES

A. Exposed head oval phillips type screws in countersunk holes unless otherwise specified. Use screws, bolts, washers, grommets, nuts, and other fastening devices of appropriate length, type, head, metal and finish as necessary for proper match and application of hardware.

2.7 GENERAL CONSTRUCTION & FABRICATION

A. Verify field conditions and dimensions prior to fabrication.
   1. Notify Architect when field dimensions are at variance with reviewed shop drawings.
   2. Corrective measures, if required, shall be determined and approved prior to fabrication.

B. Coordinate door assembly details with details of adjacent work to assure proper attachment and clean junctions. Fit and fabricate accurately with all surfaces free from warp, wave, buckle, and other defects.

C. Minimum gauges of hollow metal are specified below.
   1. Unless steel stiffed (see below) provide 18 gauge doors (or heavier gauge if required by fire label requirements).
   2. Provide 16 gauge frames and glazed opening frames (or heavier gauge if required by fire label requirements). Entire frame and sidelight shall be of same gauge.

D. Provide sheet steel conforming to ASTM A 366 Cold Rolled or Galvanized steel. Provide sheet steel tested with ITS (Intertek / Warnock Hersey in accordance with ASTM E-152, CAN S-104, NFPA252, UL10B and UL10C. Exceed all requirements of SDI 100.

E. Produce door hardware units of base metal, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition temper, and hardness. Furnish

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metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18 for finishes. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.

2.8 FRAMES

A. Fabricate from 16-gage, commercial-quality, cold-rolled, carbon steel sheet conforming to ASTM A366 and ASTM A568.
   1. Provide a temporary spreader bar securely fastened to the bottom of each frame, and suitable wall anchors for each jamb.
   2. Typical Reinforcing: Provide minimum hinge reinforcement 3/16 inch by 1-1/2 inch by 10 inch. Provide similar reinforcement for hardware items as required to adequately withstand stresses, minimum 12 gauge, including channel reinforcement for door closers and closer arms, door holders and similar items. Provide reinforcement and clearances for concealed in-head door closers and for mortise locks.
   3. Anchorage: Provide standard and special anchorage items as required. Provide formed steel channel spreader at bottom of frames, removable without damaging frame. At masonry, provide anchors (about 2 inch by 10 inch) approximately 24 inches on center.
   4. Joinings: At frames with equal width jambs and head, neatly miter on face (except locations as at transom bars and at frames with large head members). Cope and butt stops. Weld length of entire joint, including face and flat intersections. Grind smooth, at other frames, provide same mitered joint wherever possible (at intersection of jamb-head or jamb-sill) and at other locations butt metal neatly and full weld. If tight butt joints are utilized, joints shall be neatly caulked smooth.
   5. Workmanship: Fabricate so no grind marks, hollow or other out-of-plane areas are visible. At joints of intermediate members (such as mullions and transom bars), provide tight joining, neatly accomplished without holes, burned out spots, weld build up or other defacing work. Fill to close cracks and to preserve shapes. Tightly fit loose stops, to hairline joints.
   6. Clearances: Provide and be responsible for proper clearances at metal frames, including for gasketing. Glass clearance shall be thickness of glass plus clearance each side (1/16 inch minimum interior), adjust for installation, glass thickness to allow for glazing and sealant. Where sealed double glazing is indicated, provide rebates minimum of 3/4 inch and provide 1/4 inch clearance at glass edges. Where units fit around concrete blocks (blocks built into frames) obtain actual dimensions of blocks being used to establish minimum clearances.

B. Frames do not need to be manufactured or furnished by Syntegra Systems in order to meet UL listing.
   1. For VE/cost saving, see architectural details and coordinate separate frame and door manufactures is cost saving item. Example frame manufacturers: Door Components, Manufacturing.; Ceco Door, Co.; Curries Co.; or Steelcraft, Co. Manufacturing Groups (in accordance with CBC requirements).

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2. Coordinate with additional frame specification requirements in Division 08, Section for Hollow Metal Doors and Frames (typically 08 11 13).

2.9 DOORS

A. General:
   1. Doors shall be 1-3/4 inches thick, unless otherwise indicated on Drawings. Fabricate to sizes shown, providing necessary clearances and bevels to permit operation without binding.
   2. Seamless Vertical Edges: Construct doors with smooth flush surfaces, without visible joints or seams on exposed faces or stile edges. Interior door edge seams shall be full height wire welded and ground smooth.
   3. Doors shall be free from warp, wave, buckle or other defect. Bevel lock edge 1/8 inch in 2 inches.
   4. Provide temperature rise rating for doors in 08 17 13. Temperature rise ratings labels are to be 450°F and indicate the maximum rise in temperature above ambient temperature measured on the unexposed surface (non-fire side) of the door during the first 30 minutes of the standard fire test.

B. See additional door specification requirements in Division 08, Section for Hollow Metal Doors and Frames.

C. Steel stiffened or honeycomb:
   1. Where auto operators or card readers are part of the opening condition or function, provide reinforced 18 gauge doors steel stiffener reinforced vertically 6 inches o.c. full height and width, spot welded 5 inches o.c. to both face sheets. Stiffeners welded together top and bottom.
   2. Remaining doors to be 18 gauge honeycomb core hollow metal doors.

2.10 ACCESSORIES

A. Glass Glazing: As specified in Section 08 81 00. Comply with hollow metal door manufacturer's written instructions.

B. Glazing Stops at Rated Doors: LoPro by Anemostat or Slimline by Air Louvers, Inc. Factory primed, galvanized steel; mitered corners; prepared for countersink style screws. Fire-rating shall match door fire-rating. Size as indicated on Drawings. Install glazing stop fasteners on the non-secure side of doors. Finish in custom color as selected by Architect.

C. Glazing Stops at Non-Rated Doors: LoPro by Anemostat or Slimline by Air Louvers, Inc. Aluminum shape; mitered corners; prepared for countersink style screws. Size as indicated on Drawings. Install glazing stop fasteners on the non-secure side of doors. Finish in custom color as selected by Architect.

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2.11 HANGING HARDWARE

A. Hinges:
   1. Acceptable Manufacturers:
      a. Markar Manufacturing.
      b. Ives Manufacturing
      c. Select Hinges.
   2. Where Hardware Set have different information, refer to the following for clarification. Provide Hardware Set devices along with added devices as indicated on Drawings and detailed requirements for each type of device:
      a. Stainless steel continuous hinge cycle testing shall be in accordance with ANSI/BHMA Standard A156.26, Grade 1.
      b. Continuous hinges shall not obscure fire rated labels of the doors or frames.
      c. Provide widths sufficient to clear trim projection when door swings 180 degrees. Confirm hinge sizing with frame details. All doors shall swing 180 degrees if opening will allow. Provide wide throw hinges where required.

B. Continuous Hinges:
   1. Acceptable Aluminum and Stainless-Steel Manufacturers:
      a. Markar Manufacturing.
      b. Ives Manufacturing by Allegion.
      c. Select Hinges.
   2. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device:
      a. Provide widths sufficient to clear trim projection when door swings 180 degrees. Confirm hinge sizing with frame details. All doors shall swing 180 degrees if opening will allow. Provide wide throw hinges where required.
      b. Provide continuous hinge that meet cycle testing in accordance with ANSI/BHMA Standard A156.26, Grade 1.
      c. Stainless steel hinges shall meet abuse test per ASTM F1450.
      d. Aluminum material: Extruded tempered aluminum. Material Standard: 6063-T6 alloy. Configuration: Three interlocking extrusions in pinless assembly, installed to full height of door frame.
      e. Continuous hinges shall not obscure fire rated labels of the doors or frames.

      Where indicated in hardware groups/ sets, provide continuous hinge with adjustable fasteners feature (basis of design and required: Markar part #M91-0005-630 Adjust-A-Screw, adjustable fasteners feature or accepted equal). See website as follows:
      http://www.markar.com/Other/Markar/PDFs/Tech%20memos%20new/1/Adjust-A-Screw%20Technical%20Memo%201.25.13.pdf

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2.12 SECURING DEVICES (LATCHING SYSTEMS)

A. Acceptable Manufacturers and Products:
   1. "Syntegra Systems / Integrated Door Assemblies" manufactured by Syntegra Manufacturing (http://www.syntegrausa.com/).
      a. Provide drawings detailing doors and frames showing 90-degree open position for one leaf with 44" clear opening width requirements (closed door or frame to open door's panic exit device face in non-retracted position).

2.13 KEY SYSTEMS (CYLINDERS, CORES AND KEYS)

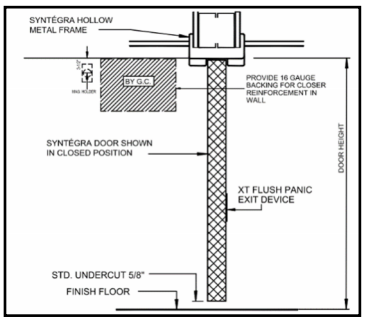
A. Coordinate with Section 08 71 00 "Door Hardware".

2.14 CLOSING DEVICE

A. Surface Mounted Closers:
   1. Acceptable Cam Action Manufacturers:
      a. LCN Manufacturing – 4040 XP Series as specified.
      b. Dorma TS93 Series only at hold open doors as specified.

B. Where Hardware Set have different information, refer to the following for clarification. Provide Hardware Set devices along with added devices as indicated on drawings and detailed requirements for each type of device:
   1. Closers to be meet ANSI A156.4, Grade 1; UL Listed; meets UL 10C for positive pressure fire test.
   2. Closers shall have multi-size spring power adjustment to permit setting of spring from 1 through 6 with additional spring power available. Provide ADA compliant setting nomenclature during submittals as recommended by closer manufacturer.
   3. Submit correct closer type as to be able to install closers on non–public side of doors.
   4. Installation Plates, Brackets, and Miscellaneous Adapters: Provide drop plates, brackets, or adapters for arms as required to suit details and install as directed by manufacturer's templates

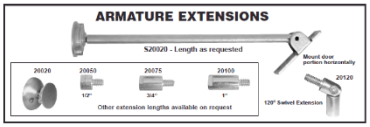
C. Furnish and install blade, angle or applied stops as required where frame does not permit installation of the standard soffit plate (see example below, field verify brackets and shims required before submittals, provide written language in submittals for how areas requiring special brackets).



D. Supply sufficient wall reinforcement to mount closer and to withstand door closing action. Where specified, coordinate wall details for pocket closers (wall reinforcement by other division as follows).

2.15 STOPS AND HOLDERS

A. Magnetic Door Holders:
   1. Acceptable Manufacturers:
      a. ABH Manufacturing.
      b. LCN Manufacturing.
      c. Rixson Manufacturing.
   2. Install using concealed fasteners. No through bolts or SNB devices allowed.
   3. Coordinate with specifications in Division 05, 06, and/or 09 for required wall backing.
   4. Coordinate with Divisions 25-28 for electrical work.
      a. Description of Operation: When door is placed in opened position, magnetic holder shall automatically engage hold open mechanism (magnet).
      b. Door releases hold open and fully closes door by manual pulling of door or by the following, self-closing functions:
         1) Close on fire alarm activation. Verify voltage and coordinate integration with fire alarm system; or
         2) Close due to loss of power. Coordinate integration with local power system.
   5. At all locations utilizing hold open magnetic devices provide correct armature length for doors (example of armature lengths in snippet/picture below).
      a. Where doors will open 90 or 180 degree swing parallel or against adjacent wall provide length required to make door 90 or 180 preferred in open position.
      b. At conditions where doors open between 90 and 180 degrees, provide armature arm application and length so that door will reach wall condition and hold doors open until fire or other alarms drop power and close doors automatically.
      c. Hinge and closer coordination is required for doors that swing more than 90 degrees (provide wide throw type hinges to clear all frame or wall obstructions in order for doors to fully open and to hide closer behind door when door are flat against a wall).



2.16 ACCESSORIES

A. Armor/Mop Plates:
   1. Acceptable Manufacturers:
      a. Ives Manufacturing.
      b. Triangle Brass Manufacturing Company, Inc. (Trimco).
      c. Rockwood.
      d. Hager Manufacturing.

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2. Size at single doors:
   a. Push side of door two inch less than door width. Hardware set/group nomenclature: 2 inches LDW.
   b. Pull side and one inch less than door width. Hardware set/group nomenclature: 1 inch LDW.
3. At pairs of doors, width shall be one inch less than door width on both sides.
4. Height shall be 10 inches, unless otherwise indicated.

B. Seals.
1. Acceptable Manufacturers:
   a. Pemko Manufacturing, Inc.
   b. National Guard.
   c. Zero International.

C. Astragals:
1. Acceptable Manufacturers:
   a. Pemko Manufacturing, Inc.
   b. National Guard.
   c. Zero International.

2.17 POWER SUPPLIES, ELECTRIFIED HARDWARE, AND WIRES

A. Door Position Switches
1. Door position switch is written in hardware sets to be coordination “place-holders”. Do not order final door position switches, but prepare doors and frames as follows: Door and frame supplier shall coordinate doors and frames to accept door position switch devices that are accepted during the submittals. Doors and frames shall be delivered to jobsite with door position switch cuts/preparations. Final switches shall be provided and installed in pre-cut frame and door head by security vendor. Coordinate with Divisions 25-28 and applicable plans.

B. Power Supplies, Wires, and Relays:
1. Where Hardware Set have different information (number of hinge wires and power supply information), refer to the following specifications for clarification and submit according to complete and intended electrified system per Contract Documents.
   a. Provide required connections to accommodate fire alarm/life safety system and/or security electronics for remote site monitoring of all electrified components and functions.

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PART 3 - EXECUTION

3.1 EXAMINATION

A. Provide notification of any wall condition or building structure that would prevent the proper execution of the installation of products produced in accordance with approved shop drawings.

B. Do not fabricate any product until receipt of an approved submittal drawings.

C. Verify that power supply is available to power operated devices.

D. Door-Floor Clearances: Unless otherwise shown, provide the following door-floor clearances:
   1. Labeled doors: 3/8 inch maximum over floor or threshold.
   2. No threshold: 3/4 inch maximum for metal doors; 5/8 inch maximum for wood doors.
   3. With threshold: 1/8 inch.
   4. Carpet: 1/8 inch over top of nap.

3.2 DOOR AND FRAME INSTALLATION

A. Set frames plumb and square, and brace until adjacent wall or finish is constructed and securely anchored.

B. Install frames in accordance with SDI-105, "Recommended Erection Instructions for Steel Frames."

C. Installed assembly shall be properly aligned with required clearances for proper operation and complying with regulatory requirements.

D. Install all devices in accordance with manufacturer's printed instructions and approved shop drawings.
   1. General: Comply with Title 24, CCR and ANSI A117.1.
   2. Except for hinges, do not install hardware until painting and finishing work is completed.
   3. Unless otherwise shown or required by CBC, place hardware at the following heights:
      a. Hinges: Door and frame manufacturer's standard.
      b. Panic Devices: Levers to be 38" above finish floor/surface. Verify manufacturer's template with door design.
      c. Door Pulls and Push Bars (centerline): 42 inches.

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3.3 HARDWARE INSTALLATION

A. Install in accordance with manufacturer's printed instructions and approved shop drawings.

B. Hardware Placement:
   1. Unless otherwise shown or required by CBC, ADA Act - 2010 Standards for Accessible Design and/or Title 24, place hardware at the following heights:
      a. Hinges: Door and frame manufacturer's standard scope per additional specifications and plans.
      b. Lever handles for latchsets, lockset and panic/exit device pull, lever trim:
         1) 38 inches above finish floor/surface.
         2) Verify manufacturer's template with door design.
         3) Panic hardware shall be so mounted / centered between 36 inches and 44 inches above finished floor or ground.
         4) Verify manufacturer's template with door design to meet CBC.
   2. Hardware for door handles, pulls, latches, locks and other operating devices for use on means of egress doors shall comply with CBC.

C. Hardware Installation:
   1. Except for hinges, do not install hardware until painting and finishing work is completed.
   2. Pre-drill pilot holes in wood for screws. Drill and tap for surface mounted hardware on metal.
   3. Hinges: Set hinges snug and flat in mortises. Hand turn screws to flat seat – do not drive.
   4. Locksets: Install locks with keyways in proper position. Install levers, roses, and escutcheons firmly affixed.
   5. Closers: Mount door closers for maximum swing of door before setting stops. Install in order for closer to meet closing function/feature so sweep and latching speed meet CBC.

3.4 PAINT OR FIELD FINISHES

A. Coordinate with Contact Documents including but not limited to Division 09 for paint and primer requirements.

B. Fire rated labels on either doors or frames shall not be painted.

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3.5 ADJUST AND CLEAN

A. Prime Coat Touch-Up: Immediately after erection, sand smooth all rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer. Touch-up shall not be obvious.

B. Cleaning and Finishing: Upon completion of the work, clean all exposed surfaces, removing any discoloration or foreign matter, and touch up all abraded or cut areas and exposed edges with finishing material recommended by the manufacturer. Touch-up of finish shall not be obvious.

C. Final Adjustments: Adjust door for smooth and balanced door movement. Check and readjust operating finish hardware in hollow metal work immediately prior to final inspection. Leave work in complete and proper operating condition.

D. Defective Work: Remove and replace defective work, including doors and frames which are warped, bowed or otherwise damaged, as directed by Architect, at no cost to Owner.

E. Protection: Protect installed hollow metal work against damage from other construction work.

F. Replace units that cannot be adjusted and lubricated to operate freely and smoothly as intended for the application.

G. Adjust door closer devices:
   1. Adjust closer operating effort.

H. When fire doors are required, the maximum effort to operate the door may be increased to the minimum allowed by the appropriate administrative authority, not to exceed 15 pounds opening force.
   1. Adjust closer delay and operating speeds to comply with requirements of CBC and ADA – Americans with Disabilities Act - 2010 Standards for Accessible Design.

I. Door closers shall have sweep period adjusted so that from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3" from the strike.

3.6 CLEAN-UP

A. Upon completion of the work of this Section, remove all excess materials, rubbish, and debris from the premises.

3.7 HARDWARE SCHEDULE

A. Manufacturers Legend

Code	Name
IV	Ives Manufacturing
MA	Markar Manufacturing
Mc	McKinney Manufacturing
SY	Syntegra Manufacturing
DO	Dorma Manufacturing
PE	Pemko Manufacturing
AB	ABH Manufacturing
TR	Trimco Manufacturing

B. Hardware Columns - Example (Legend):

Qty	Device Description	Device # (include specification language)	Finish	
	Manu			
1	- - - - - - - - - - - -	- - - - - - - - - - - -	- -	- -

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D. The following hardware sets are intended to establish type and standard of quality when used together with the requirements of this Section (see above section and related sections including Division 01).

1. Examine Contract Documents and furnish proper hardware for door openings.
2. Refer to Door Schedule on the Drawings for Hardware Group/Set assignments for each opening.

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For all doors assigned Hardware Set #101 on the door schedule, provide the following:

In addition to the devices specified in hardware group/set below, also coordinate devices in specification Sections 087113 "Automatic Door Operators" and 087100 "Door Hardware" (furnish & install doors, frames and related scope per complete Contract Documents):			
2	Ea.	Hollow Metal Door Swing Clear Continuous Hinges with adjustable fasteners	#HG-326 x M91-0005-630 (Adjust-A-Screw, adjustable fasteners feature or accepted equal) x reinforcement as required by doors/frames x prep for 4612-1-SC ELX EPT
2	Ea.	Electrified Power Transfer Device	#4612-1-SC ELX by Adams Rite (or equal by Syntegra) for doors receiving swing clear hinges
2	Ea.	Electric Latch Retraction Integrated Doors and Panic Bars with Locked Lever (same-swing pair doors one door only with lever)	Syntegra Integrated Door #XT-ML (motor latch retraction) x Matching End Caps - BHMA 03 Storeroom Lever (RHR always locked lever one door only, lever style to match Schlage #06 project specific lever). Verify in shop drawings/submittals pocket or wall has room the active door lever behind opening when door is open 90 degrees. - Smaller or inactive leaf will not have exterior trim - Finish: BHMA 630.
2	Ea.	Auto Operator, Push-Plates and System Components	Auto Operator complete system per Section 087113 "Automatic Door Operators"
2	Ea.	Armor Plate	KA050 34" tall x 3" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners) x 630 finish by Trimco manufacturing or equal by Syntegra
1	Ea.	Cylinders (Rim or Mortise)	By Section 087100: Mortise series x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)
1	Ea.	Permanent Core	By Section 087100
2	Ea.	Wall Stops	By Section 087100
1	Ea.	Seals	S88D seals (head and jambs) by Pemko or approved
2	Ea.	Split Astragals	29310CS by Pemko or approved seal manufacturer
1	Ea.	Power Supply	Furnish and install #1) single gang power drop located above or near door (not in corridor or public view, but above celling line where possible); #2) provide power supply by Syntegra: At non-rated doors Syntegra #PS202B with battery backup for additional auto operator opening cycles when there is power loss; or at smoke or fire rated doors Syntegra #PS202 with fire alarm input to drop power to latch retraction and drop power to auto operators in FLS event; #3) run conduit from hinge through frame and complete

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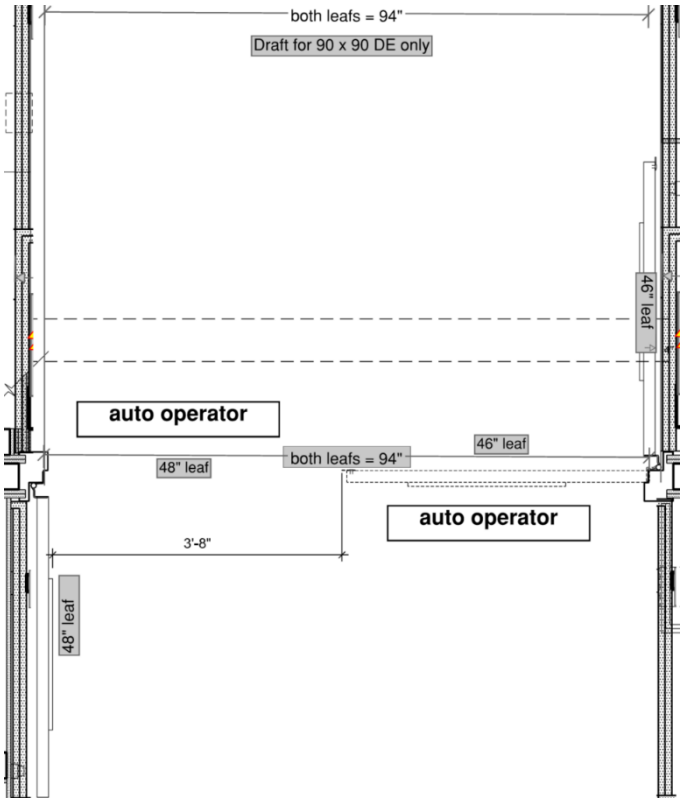
			wiring as required to meet manufacturer warranties
__	Ea.	Door Position Switch (door contacts)	See note below as this Section does not direct card reader locations or non-Div. 08 security devices
__	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope [including but not limited to #1) wire / connectivity from ceiling through frame to electrified hardware, #2) Door Position Switch (also known as door contacts); #3) REX security switch (see free egress note in above specifications)]	Coordinate with security or electrical Divisions 25-28 and applicable drawings: - If these security devices (wire/connectivity/card readers) are added or deleted from project 087100 doors do not require updates as hardware does not direct card reader or non-087100 security devices. - The electrified hardware specified above can be utilized for #1) non-card reader, remote access control applications (unlocked / locked remotely for open during business hours / locked after-hours) and #2) or could be utilized for local card readers at openings as directed by security drawings. - All project doors have free egress at all times with no special knowledge to exit. The free egress side of door "REX" feature is a security feature that announces/tells the security system if occupant is leaving the building interior area, egress side of door and will not in any way affect free egress. REX security switch/contact part that requires coordination with security is specified in above locking hardware. - If door position switch is require by security drawings as they are at all doors assigned card readers, template door and frame to receive security specified door position switch diameter/size (per this contractual wording, this is means and methods and not designer work, 081713 to bid hours to verify security drawings before hardware submittals and submit separate line item for each project door that requires door position switches listing size to be cut in door and/or frame).
Note: Furnish and install all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices required in specifications language above, architectural plans and full specification documents).			

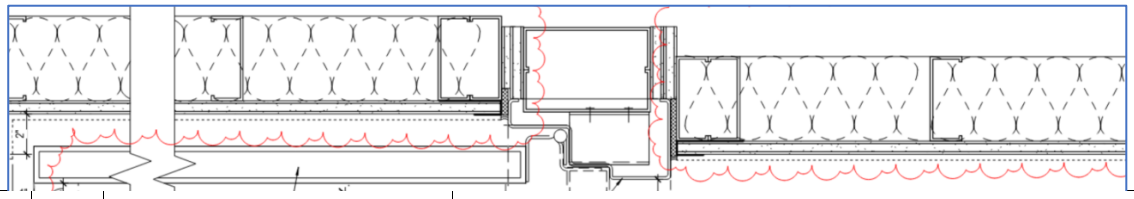
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For all doors assigned Hardware Set #101.1 on the door schedule, provide the following:

In addition to the devices specified in hardware group/set below, also coordinate devices in specification Sections 087113 "Automatic Door Operators" and 087100 "Door Hardware" - furnish & install doors, frames including frame - example in snippets for dual egress frame buried in rated walls) and related scope per complete Contract Documents):





2	**Ea.**	**Hollow Metal Door Swing Clear Continuous Hinges with adjustable fasteners**	**#HG-326 x M91-0005-630 (Adjust-A-Screw, adjustable fasteners feature or accepted equal) x reinforcement as required by doors/frames x prep for 4612-1-SC ELX EPT**
2	**Ea.**	**Electrified Power Transfer Device**	**#4612-1-SC ELX by Adams Rite (or equal by Syntegra) for doors receiving swing clear hinges**
2	**Ea.**	**Electric Latch Retraction Integrated Doors and Panic Bars with no trim**	**Syntegra Integrated Door #XT-ML (motor latch retraction) x Request Monitor (REX) x Matching End Caps with no pull-side trim (exit only with panic bar on push-side of each leaf; one leaf 46" and the other 28" to meet the required clearance width). Finish: BHMA 630.**
2	**Ea.**	**Auto Operator, Push-Plates and System Components**	**Auto Operator complete system per Section 087113 "Automatic Door Operators"**

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2	**Ea.**	**Armor Plate**	**KA050 34" tall x 3" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners) x 630 finish by Trimco manufacturing or equal by Syntegra**
2	**Ea.**	**Wall Stops**	**By Section 087100**
1	**Ea.**	**Seals**	**S88D seals (head and jambs) by Pemko or approved**
2	**Ea.**	**Overlapping Astragals**	**357 welded, ground smooth, prime, painted to match doors by Pemko or approved seal manufacturer x S77D full height seal**
1	**Ea.**	**Power Supply**	**Furnish and install #1) single gang power drop located above or near door (not in corridor or public view, but above celling line where possible); #2) provide power supply by Syntegra: At non-rated doors Syntegra #PS202B with battery backup for additional auto operator opening cycles when there is power loss; or at smoke or fire rated doors Syntegra #PS202 with fire alarm input to drop power to latch retraction and drop power to auto operators in FLS event; #3) run conduit from hinge through frame and complete wiring as required to meet manufacturer warranties**
__	**Ea.**	**Door Position Switch (door contacts)**	**See note below as this Section does not direct card reader locations or non-Div. 08 security devices**
__	**Ea.**	**Coordination task for security and/or electrical design and additional non-Division 08 Section scope [including but not limited to #1) wire / connectivity from ceiling through frame to electrified hardware, #2) Door Position Switch (also known as door contacts); #3) REX security switch (see free egress note in above specifications)]**	**Coordinate with security or electrical Divisions 25-28 and applicable drawings:** **- If these security devices (wire/connectivity/card readers) are added or deleted from project 087100 doors do not require updates as hardware does not direct card reader or non-087100 security devices.** **- The electrified hardware specified above can be utilized for #1) non-card reader, remote access control applications (unlocked / locked remotely for open during business hours / locked after-hours) and #2) or could be utilized for local card readers at openings as directed by security drawings.** **- All project doors have free egress at all times with no special knowledge to exit. The free egress side of door "REX" feature is a security feature that announces/tells the security system if occupant is leaving the building interior area,**

			egress side of door and will not in any way affect free egress. REX security switch/contact part that requires coordination with security is specified in above locking hardware. **- If door position switch is require by security drawings as they are at all doors assigned card readers, template door and frame to receive security specified door position switch diameter/size (per this contractual wording, this is means and methods and not designer work, 081713 to bid hours to verify security drawings before hardware submittals and submit separate line item for each project door that requires door position switches listing size to be cut in door and/or frame).**
Note: Furnish and install all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices required in specifications language above, architectural plans and full specification documents).			

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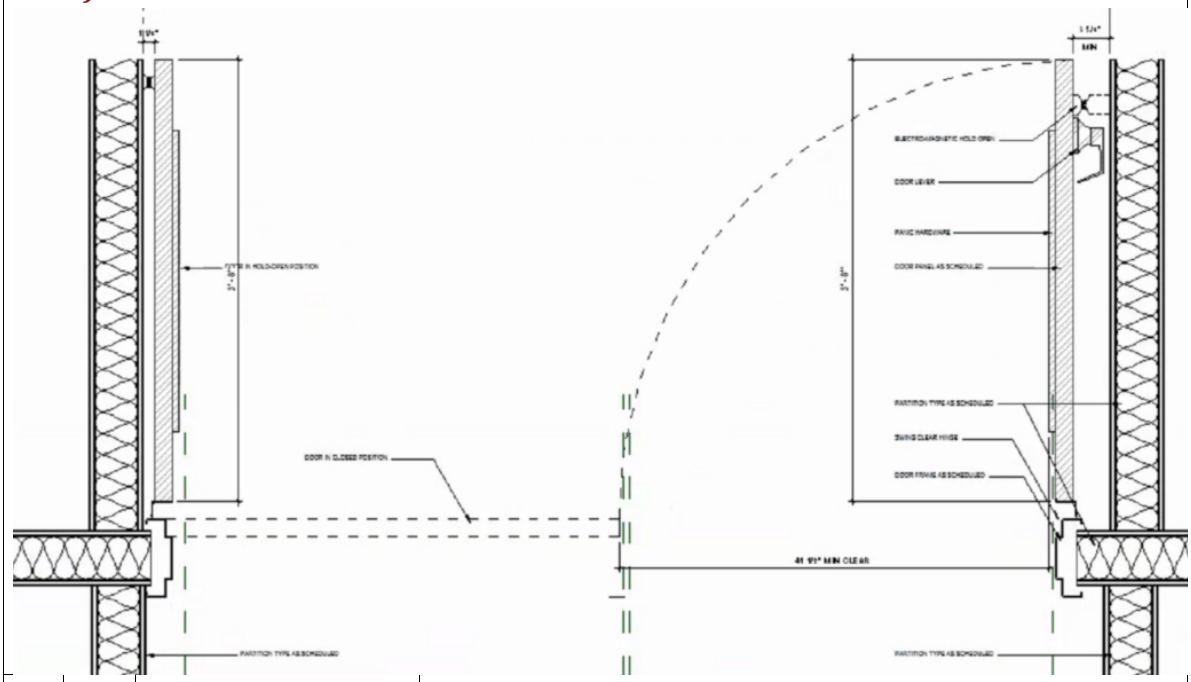
For all doors assigned Hardware Set #103 on the door schedule, provide the following:

In addition to the devices specified in hardware group/set below, also coordinate devices in specification Sections 087113 "Automatic Door Operators" and 087100 "Door Hardware" (furnish & install doors, frames and related scope per complete Contract Documents):			
2	Ea.	Hollow Metal Door Swing Clear Continuous Hinges with adjustable fasteners	#HG-326 x M91-0005-630 (Adjust-A-Screw, adjustable fasteners feature or accepted equal) x reinforcement as required by doors/frames x prep for 4612-1-SC ELX EPT
2	Ea.	Electrified Power Transfer Device	#4612-1-SC ELX by Adams Rite (or equal by Syntegra) for doors receiving swing clear hinges
2	Ea.	Integrated Doors and Panic Bars with Passage Lever (same-swing pair doors one door only with passage lever)	Syntegra Integrated Door #XT-ML (motor latch retraction) x 630 finishes for BHMA hardware - Passage Lever (LHR door only, lever style to match Schlage #06 project specific lever). Verify in shop drawings/submittals pocket or wall has room the active door lever behind opening when door is open 90 degrees. - Smaller or inactive leaf will not have exterior trim - Finish: BHMA 630.
2	Ea.	Auto Operator, Push-Plates and System	Auto Operator complete system per Section 087113 "Automatic Door Operators"
2	Ea.	Armor Plate	KA050 34" tall x 3" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners) x 630 finish by Trimco manufacturing or equal by Syntegra
1	Ea.	Seals	S88D seals (head and jambs) by Pemko or approved
2	Ea.	Split Astragals	29310CS by Pemko or approved seal manufacturer
1	Ea.	Power Supply	Furnish and install #1) single gang power drop located above or near door (not in corridor or public view, but above celling line where possible); #2) provide power supply by Syntegra: At non-rated doors Syntegra #PS202B with battery backup for additional auto operator opening cycles when there is power loss; or at smoke or fire rated doors Syntegra #PS202 with fire alarm input to drop power to latch retraction and drop power to auto operators in FLS event; #3) run conduit from hinge through frame and complete wiring as required to meet manufacturer warranties
1	Ea.	Coordination task for electrical design and additional non-Division 08 Section scope for wire / connectivity from ceiling through frame to electrified hardware)	Coordinate with electrical Divisions 25-28 and applicable drawings
Note: Furnish and install all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices required in specifications language above, architectural plans and full specification documents).			

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For all doors assigned Hardware Set #106 on the door schedule, provide the following:

Furnish & install doors, frames including frame as shown in example snippets for single rabbit frame and 4" behind large leaf when leaf is open 90 degrees for required lever):



__	Ea.	Swing Clear Hinge	T4A3795 5 inch or beveled edge T4A4795 5 inch as required per opening (quantity per 081713) x 652 finish by McKinney or equal hinge by Syntegra
1	Ea.	Auto Flush Bolt (top latch only)	#3810 (metal doors) x #3850 (no bottom bolt or dust proof strike) x 626/630 finish by Trimco manufacturing or equal by Syntegra
1	Ea.	Integrated Doors and Panic Bars with Passage Lever (same-swing pair doors one door only with passage lever)	Syntegra Integrated Door #XTx 630 finishes for BHMA hardware - Passage Lever (one door only, lever style to match Schlage #06 project specific lever). Verify in shop drawings/submittals pocket or wall has room the active door lever behind opening when door is open 90 degrees. - Smaller or inactive leaf will not have exterior trim - Finish: BHMA 630.
~~12~~	Ea.	Coordinator	#3094 series x filler plates x mounting brackets as required for coordinated hardware by Trimco manufacturing or equal by Syntegra
2	Ea.	~~Pocket~~ **Surface** Closer	~~TS93-1 90-degree~~ **4040XP parallel arm** x 689 finish by ~~Dorma~~ **LCN** manufacturing or equal by Syntegra
~~2~~	~~Ea.~~	~~Pocket Closer – Wall Backing~~	~~Furnish & install fire treated wood backboard plate or 18 gauge steel backboard plate (size as required)~~

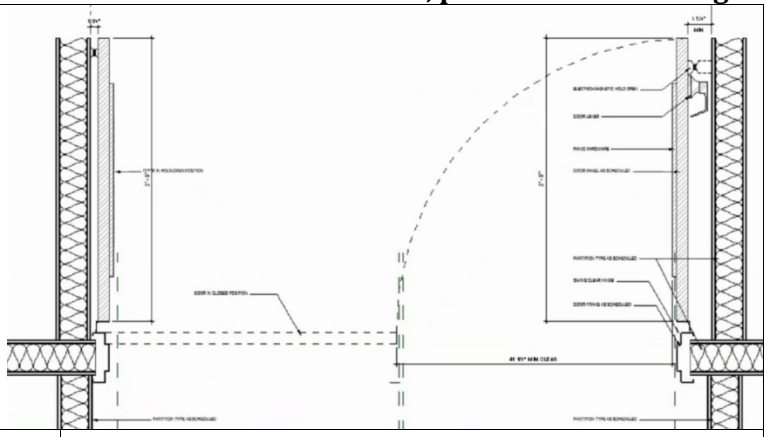
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~~3~~**2**	Ea.	Wall Mag Holder Devices	2400L series x armature extension x 689 finish by ABH manufacturing or equal by Syntegra
~~3~~**2**	Ea.	Wall Mag Armature Extensions	S20020 (or length as ~~required 180~~**required 90** degree swing parallel to adjacent wall) x 689 finish by ABH manufacturing or equal by Syntegra
2	Ea.	Kick Plate	KO050 12” tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners) x 630 finish by Trimco manufacturing or equal by Syntegra
1	Ea.	Seals	S88D seals (head and jambs) by Pemko or approved
1~~2~~	Ea.	~~Split~~ **Overlapping** Astragals	**357 welded, ground smooth, prime, painted to match doors by Pemko or approved seal manufacturer x S77D full height seal**~~29310CS by Pemko or approved seal manufacturer~~
Note 1: Furnish and install all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices required in specifications language above, architectural plans and full specification documents). Note 2: Description of Operation: When door is placed in opened position, Magnetic Holder will automatically engage hold open mechanism (magnet). Door releases hold open and fully closes door by manual pulling of door or by the following, self-closing functions: 1) Close on fire alarm activation (Verify voltage and coordinate integration with fire alarm system; or 2) Close due to loss of power (coordinate integration with local power system). Coordinate with divisions 25-28 and applicable FLS drawings.			

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For all doors assigned Hardware Set #107 on the door schedule, provide the following:

Furnish & install pair doors, frames including frame as shown in example snippet for single rabbit frame and 4" behind large leaf when leaf is open 90 degrees for required lever):			
—	Ea.	Swing Clear Hinge	T4A3795 5 inch or beveled edge T4A4795 5 inch as required per opening (quantity per 081713) x 652 finish by McKinney or equal hinge by Syntegra
1	Ea.	Electrified Power Transfer Device	#4612-1-SC ELX by Adams Rite (or equal by Syntegra) for doors receiving swing clear hinges
1	**Ea.**	**Auto Flush Bolt (top latch only)**	**#3810 (metal doors) x #3850 (no bottom bolt or dust proof strike) x 626/630 finish by Trimco manufacturing or equal by Syntegra**
1	Ea.	Electric Latch Retraction Integrated Doors and Panic Bars with Locked Lever	Syntegra Integrated Door #XT-ML (motor latch retraction) x Matching End Caps - BHMA 03 Storeroom Lever. Verify in shop drawings/submittals pocket or wall has room the active door lever behind opening when door is open 90 degrees. - Finish: BHMA 630.
1	**Ea.**	**Coordinator**	**#3094 series x filler plates x mounting brackets as required for coordinated hardware by Trimco manufacturing or equal by Syntegra**
2 ~~1~~	Ea.	Surface Closer	4040XP parallel arm x 689 finish by LCN manufacturing
2 ~~1~~	Ea.	Armor Plate	KA050 34" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners) x 630 finish by Trimco manufacturing or equal by Syntegra
1	Ea.	Cylinders (Rim or Mortise)	By Section 087100: Mortise series x appropriate cam x blocking rings as required (rim or mortise type and quantity as required by locking device)
1	Ea.	Permanent Core	By Section 087100
2 ~~1~~	Ea.	Wall Stops	By Section 087100
1	Ea.	Seals	S88D seals (head and jambs) by Pemko or approved

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1	**Ea.**	**Overlapping Astragals**	**357 welded, ground smooth, prime, painted to match doors by Pemko or approved seal manufacturer x S77D full height seal**
1	Ea.	Power Supply	Furnish and install #1) single gang power drop located above or near door (not in corridor or public view, but above celling line where possible); #2) provide power supply by Syntegra: At non-rated doors Syntegra #PS202B with battery backup for additional auto operator opening cycles when there is power loss; or at smoke or fire rated doors Syntegra #PS202 with fire alarm input to drop power to latch retraction and drop power to auto operators in FLS event; #3) run conduit from hinge through frame and complete wiring as required to meet manufacturer warranties
__	Ea.	Door Position Switch (door contacts)	See note below as this Section does not direct card reader locations or non-Div. 08 security devices
__	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope [including but not limited to #1) wire / connectivity from ceiling through frame to electrified hardware, #2) Door Position Switch (also known as door contacts); #3) REX security switch (see free egress note in above specifications)]	Coordinate with security or electrical Divisions 25-28 and applicable drawings: - If these security devices (wire/connectivity/card readers) are added or deleted from project 087100 doors do not require updates as hardware does not direct card reader or non-087100 security devices. - The electrified hardware specified above can be utilized for #1) non-card reader, remote access control applications (unlocked / locked remotely for open during business hours / locked after-hours) and #2) or could be utilized for local card readers at openings as directed by security drawings. - All project doors have free egress at all times with no special knowledge to exit. The free egress side of door “REX” feature is a security feature that announces/tells the security system if occupant is leaving the building interior area, egress side of door and will not in any way affect free egress. REX security switch/contact part that requires coordination with security is specified in above locking hardware. - If door position switch is require by security drawings as they are at all doors assigned card readers, template door and frame to receive security specified door position switch diameter/size (per this contractual wording, this is means and methods and not designer work, 081713 to bid hours to verify security drawings before hardware submittals and submit separate line item for each

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			project door that requires door position switches listing size to be cut in door and/or frame).
Note: Furnish and install all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices required in specifications language above, architectural plans and full specification documents).			

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For all doors assigned Hardware Set #112 on the door schedule, provide the following:

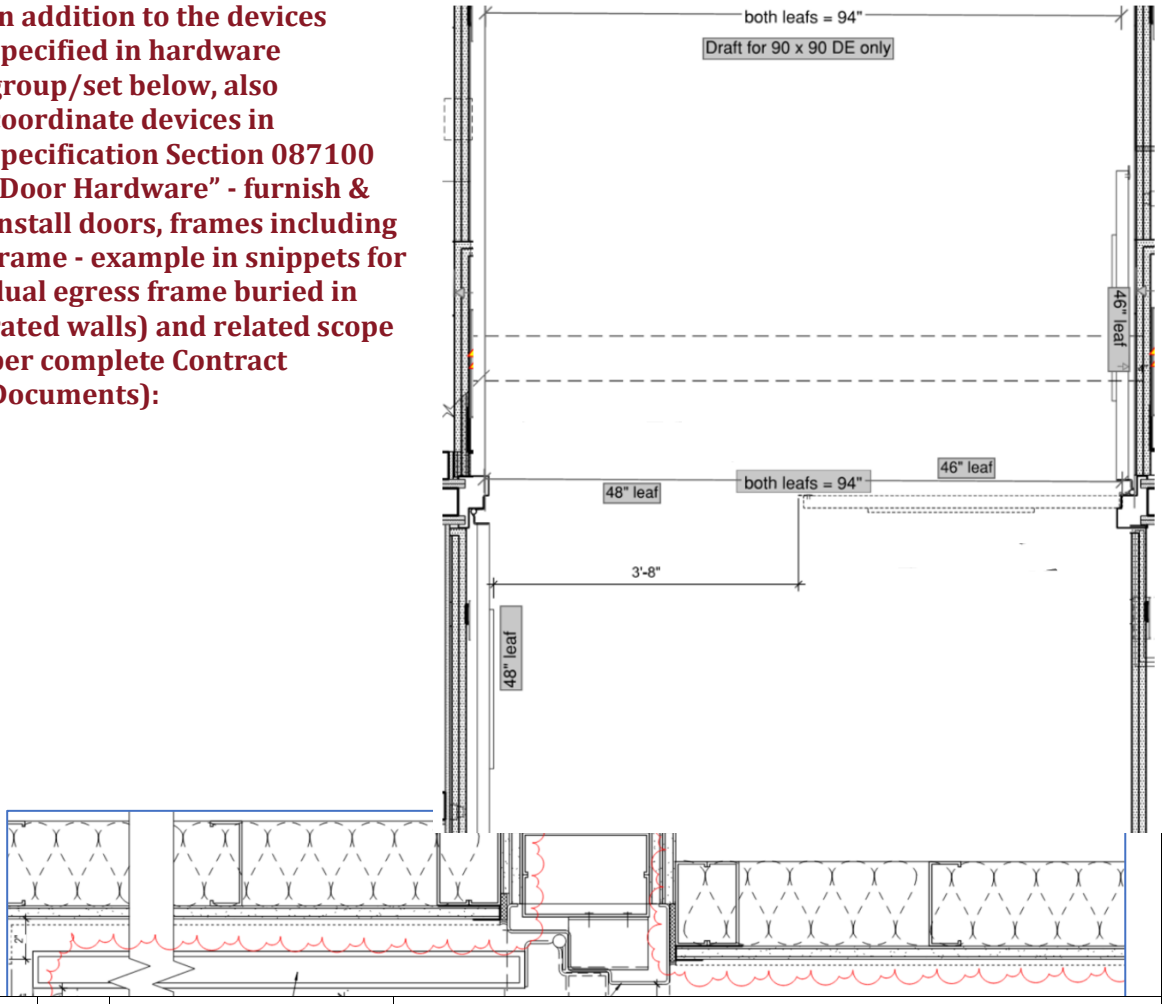
__	Ea.	Continuous Hinge	FM300 x 630 finish by Markar or equal hinges by Syntegra
1	Ea.	Integrated Door and Panic Bar with Passage Lever	Syntegra Integrated Door #XT x 630 finishes for BHMA hardware x Passage Lever
1	Ea.	Surface Closer	4040XP 180-degree parallel arm x 689 finish by LCN manufacturing
1	Ea.	Armor Plate	KA050 34" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners) x 630 finish by Trimco manufacturing or equal by Syntegra
1	Ea.	Wall Stop	By Section 087100
1	Ea.	Seals	S88D seals (head and jambs) by Pemko or approved
Note: Furnish and install all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices required in specifications language above, architectural plans and full specification documents).			

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For all doors assigned Hardware Set #124 on the door schedule, provide the following:

In addition to the devices specified in hardware group/set below, also coordinate devices in specification Section 087100 "Door Hardware" - furnish & install doors, frames including frame - example in snippets for dual egress frame buried in rated walls) and related scope per complete Contract Documents):



__	Ea.	Swing Clear Hinge	T4A3795 5 inch or beveled edge T4A4795 5 inch as required per opening (quantity per 081713) x 652 finish by McKinney or equal hinge by Syntegra
2	Ea.	Electric Latch Retraction Integrated Doors and Panic Bars with no trim	Syntegra Integrated Door #XT-ML (motor latch retraction) x Request Monitor (REX) x Matching End Caps with no pull-side trim (exit only with panic bar on push-side of each leaf; one leaf 46" and the other 28" to meet the required clearance width). Finish: BHMA 630.
2	Ea.	Surface Closer	4040XP parallel arm x 689 finish by LCN manufacturing or equal by Syntegra
2	Ea.	Wall Mag Holder Devices	2400L series x armature extension x 689 finish by ABH manufacturing or equal by Syntegra
2	Ea.	Wall Mag Armature Extensions	S20020 (or length as required 90 degree swing parallel to adjacent wall) x 689 finish by ABH manufacturing or equal by Syntegra
2	Ea.	Kick Plate	KO050 12" tall x 2" LDW (less door width) x B4E

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			(beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners) x 630 finish by Trimco manufacturing or equal by Syntegra
1	**Ea.**	**Seals**	**S88D seals (head and jambs) by Pemko or approved**
1	**Ea.**	**Overlapping Astragals**	**357 welded, ground smooth, prime, painted to match doors by Pemko or approved seal manufacturer x S77D full height seal**
Note 1: Furnish and install all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices required in specifications language above, architectural plans and full specification documents). **Note 2: Description of Operation: When door is placed in opened position, Magnetic Holder will automatically engage hold open mechanism (magnet). Door releases hold open and fully closes door by manual pulling of door or by the following, self-closing functions: 1) Close on fire alarm activation (Verify voltage and coordinate integration with fire alarm system; or 2) Close due to loss of power (coordinate integration with local power system). Coordinate with divisions 25-28 and applicable FLS drawings.**			

END OF SECTION

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SECTION 08 31 16 – ACCESS PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Metal access panel assemblies.
   2. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

1.2 REFERENCES

A. Abbreviations and Acronyms:
   1. BMT: Base Metal Thickness.

B. Definitions:
   1. Manufacturer: Means the access panel manufacturer, unless otherwise indicated.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate locations of items and equipment being accessed with access panel sizes and locations indicated on the Drawings.
   2. Coordinate hardware preparations, handing, reinforcement requirements, and locations with the Drawings, access panel manufacturer, and selected hardware sets.

B. Acoustical Requirements:
   1. Provide fire-rated access doors with continuous piano-style hinges at sound-rated construction.
   2. Seal door flange perimeter with “S88” adhesive-backed fire and smoke gasketing manufactured by Pemko Manufacturing Co., Inc., or equal.
   3. Seal entire assembly to gypsum board with acoustical sealant.
   4. Include 1-1/2-inch-thick minimum insulation laminated with at least 2 pound per square foot density material such as gypsum board.

1.4 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).

1. Product Data: Submit manufacturer's product data, specifications, typical installation details, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs) and safety data sheets (SDSs) both of which are returned to the Contractor without review or responsive action.
2. Shop Drawings:
   a. Submit dimensioned plans and elevations drawn to scale and showing access panel locations, sizes, and extents of all items, accessories, and trim. Label manufactured items by product name.
   b. Include project-specific dimensioned details drawn to scale showing conditions not detailed on the product data; or that are detailed, but not in a manner specific to the project. Cross-reference details to plans and elevations.

B. Informational Submittals: Submit manufacturer's instructions for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
1. Submit manufacturer-prepared published instructions for proper installation of furnished access panels.
2. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.
3. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.

1.5 QUALITY ASSURANCE

A. Source Limitations:
1. Access panels must be obtained through one source from the same manufacturer (to ensure compatibility, regulatory conformance, and a warrantable installation).
   a. Certain items may be obtained from more than one manufacturer, but only when used for separate installations.
   b. Items provided for each different installation must be obtained from the same source and manufacturer.
2. Provide secondary materials, components, accessories and other items from sources required, recommended, or accepted by the primary manufacturer for actual in-service conditions applicable to the project.

1.6 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
2. Reject items that are not transported, delivered, or protected in conformance with manufacturer-recommended transport, delivery, and receiving requirements.

3. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items indoors as shipped, upright in their original packaging or containers, within dry, well-ventilated, broom-cleaned and enclosed storage areas.

C. Handling: Handle items in conformance with manufacturer's instructions and other requirements and recommendations, and in a manner that that prevents damage. Avoid damage to packaging and containers, and contamination of contents.

D. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective access panels with undamaged new access panels that do not exhibit deterioration, damage, or defects.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

PART 2 - PRODUCTS

2.1 METAL ACCESS PANEL AND FRAMES

A. Manufacturers: Provide products manufactured by one of the following, or equal.
1. Activar Construction Products Group, Inc.
2. Acudor Products, Inc.
3. Karp Associates, Inc.
4. Nystrom Building Products.

B. Non-Rated Access Panels at Ceramic Tile Wall Finishes:
1. Description: Flush stainless steel access panels and frames.
2. Product: "JL Industries Model TMS" manufactured by Activar Construction Products Group, Inc., or equal.
3. Material: Type 304, 0.0625-inch BMT (USSG 16) stainless steel frame with at least 0.0625-inch BMT (USSG 16) stainless steel door.
4. Trim: At least 0.0312-inch BMT (USSG 22) stainless steel flange.
5. Hinge: Concealed continuous piano hinge.

C. Non-Rated Access Panels Elsewhere:
1. Description: Flush concealed frame access panels with wallboard bead.
2. Product: "JL Industries Model TMW" manufactured by Activar Construction Products Group, Inc., or equal.
3. Material: At least 0.0598-inch BMT (MSG 16) cold-rolled uncoated steel sheet frame and 0.0598-inch BMT (MSG 16) cold-rolled uncoated steel sheet door.
4. Trim: At least 0.0299-inch BMT (MSG 22) HDG steel sheet gypsum board tape-in bead flange.

5. Hinge: Concealed continuous piano hinge.
6. Finish: Manufacturer's standard shop-applied phosphate pre-treatment and baked on rust inhibitive primer for field-applied finish.

D. Fire-Resistance Rated Access Panels:
1. Description: Fire-rated and insulated concealed frame access panel with wallboard bead.
2. Product: "JL Industries Model FDW" manufactured by Activar Construction Products Group, Inc., or equal.
3. Material: At least 0.0598-inch BMT (MSG 16) cold-rolled uncoated steel sheet frame with At least 0.0359-inch BMT (MSG 20) cold-rolled uncoated steel sheet door.
4. Trim: At least 0.0299-inch BMT (MSG 22) HDG steel sheet gypsum board tape-in bead flange.
5. Insulation: At least 2-inch thick fire-resistive mineral wool insulation sandwiched between access panel faces.
6. Hinge: Concealed continuous piano hinge.
7. Finish: Manufacturer's standard shop-applied phosphate pre-treatment and baked on rust inhibitive primer for field-applied finish.

E. Requisite Properties:
1. Provide at least 24-inch square or larger panel assemblies where servicemen must access spaces through panels.
2. Elsewhere, provide at least 12-inch square panel assemblies.

F. Accessories:
1. Locking Devices:
a. Public Areas: Provide one mortise cylinder lock per access door. Key all locks alike, unless otherwise noted.
b. Other Areas: Provide flush, key-operated cam lock. Key all locks alike, unless otherwise noted.
c. Panels 24 inches or More in Any Dimension: Provide interior latch to permit access panel opening from inside without a key.
2. Gaskets: Apply manufacturer's optional gasketing to frames of units that do not come standard with gaskets.
3. Fastenings: Provide backings, inserts, loose connection hardware, fasteners, anchors, attachments, connectors, and other items supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.
4. Other Accessories: Provide other accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification: Verify in-place supporting and adjacent construction conforms to the manufacturer's requirements or recommendations and satisfies all other conditions that might affect the quality of installation or the durability, appearance, or performance of installed and adjacent items.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.
   2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 INSTALLATION

A. General Requirements:
   1. Install access panels using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
   2. Set items true to line, to required levels and lines, and plumb, level, and square, without warp or rack, with flush well-fitted joints, and in alignment with adjacent construction
   3. Installed access panels must be warrantable. Do not install, correct, or replace access panels in a manner that results in any warranty or guarantee becoming void.

B. Interface with Adjacent Items: Provide materials, components, and accessories normally furnished or necessary to securely attach access panels to supporting construction.

C. Installation Tolerances: Install access panels to an allowable tolerance variation of not more than 1/4-inch from true position and not more than 1/8-inch from plumb, level, and alignment.

3.3 ADJUSTING

A. Verify smooth and quiet access panel door and hardware operation.

B. Lubricate and adjust operating parts and hardware to function properly, free from warp, twist, binding, and distortion. Confirm latches and locks engage securely without forcing or binding.

C. Replace items that do not operate freely in a safe and reliable manner.

3.4 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
   1. written descriptions of non-conforming, damaged, and defective work;
   2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
   3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.5 CLEANING

A. Cleaning Work: Clean all visible access panel surfaces in a manner that does not result in any warranty or guarantee becoming void.
   1. Use cleaning materials, equipment, and accessories supplied, and means, methods, techniques, and procedures required, recommended, or accepted by the manufacturer.
   2. Do not use cleaning materials or procedures known to change, or that might change, the appearance of exposed finishes or adjacent surfaces; or cause deterioration or damage to exposed finishes or adjacent surfaces.
   3. Protect adjacent surfaces not being cleaned from staining, deterioration, damage, or other detrimental effects caused by cleaning.
   4. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be cleaned to the Architect's acceptance.

B. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

3.6 PROTECTION

A. Protect installed access panels in place from soiling, deterioration, and damage until Substantial Completion.

B. Do not store anything on or adjacent to or against installed access panels unless they are protected from damage, as accepted in writing by the manufacturer's representative. Do not use installed access panels as work surfaces.

C. Remove protection when it's no longer needed and before Substantial Completion.

END OF SECTION

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SECTION 08 42 43 – ICU-CCU ENTRANCES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Manual slide ICU/CCU entrance door assemblies.
   2. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

1.2 REFERENCES

A. Definitions:
   1. Manufacturer: Means the ICU/CCU entrance manufacturer, unless otherwise indicated.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate building opening tolerances with ICU/CCU entrance manufacturing and erection tolerances.
   2. Coordinate ICU/CCU entrance hardware finishes with door hardware finishes.

1.4 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data:
      a. Submit manufacturer's product data, specifications, typical installation details, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs) and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
      b. Submit sample warranties with warranty periods, terms, conditions, exclusions, and remedies explicitly defined for each warranty, including clear warranty period start dates. (e.g., date of manufacture, purchase, installation, Beneficial Occupancy, Substantial Completion, Final Completion, etc.)
   2. Door Schedule: Submit schedule showing opening identification symbols and entrance door and frame types and sizes, including thickness, swing, fire-resistance

rating label requirements, and undercuts. Use the same reference numbers for openings and details as the Drawings.

3. Shop Drawings:
   a. Submit dimensioned plans and elevations drawn to scale and showing ICU/CCU entrance layout, materials, construction, and finishes. Show locations, sizes, and extents of all items, accessories, and trim. Label manufactured items by product name.
   b. Include project-specific dimensioned details drawn to scale showing conditions not detailed on the product data; or that are detailed, but not in a manner specific to the project. Cross-reference details to plans and elevations.
4. Samples:
   a. Submit at least 6-inch square representative samples of each ICU/CCU entrance frame and sash color and finish.

B. Informational Submittals: Submit the following for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
1. Manufacturer's Instructions: Submit manufacturer-prepared published instructions for proper installation of furnished ICU/CCU entrances.
   a. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.
   b. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.
2. Qualification Statements: Submit written descriptions confirming experience specified in QUALITY ASSURANCE article below.

C. Closeout Submittals: Submit the following to the Architect as a condition of project closeout.
1. Maintenance Data: Submit copies of manufacturer's instructions and other requirements and recommendations for door maintenance, cleaning, and repair.
2. Warranty Documentation: Submit final warranties signed by the manufacturer's representative with complete terms indicated for all warranties covering items furnished or installed under this specification section.

1.5 QUALITY ASSURANCE

A. Source Limitations:
1. ICU/CCU entrances must be obtained through one source from the same manufacturer (to ensure compatibility, regulatory conformance, and a warrantable installation).
   a. Certain items may be obtained from more than one manufacturer, but only when used for separate installations.

b. Items provided for each different installation must be obtained from the same source and manufacturer.

2. Provide secondary materials, components, accessories and other items from sources required, recommended, or accepted by the primary manufacturer for actual in-service conditions applicable to the project.

B. Qualifications:

1. Manufacturer: Company or individuals must have at least 10 years' experience manufacturing ICU/CCU entrances installed on at least 200 previous projects similar to this project in size, material, design, and complexity.
2. Installer: Company or individuals must have at least 5 years' experience installing ICU/CCU entrances for at least 30 previous projects similar to this project in size, material, design, and complexity.
3. Supervisors: Individuals must have at least 7 years' experience installing ICU/CCU entrances for at least 30 previous projects similar to this project in size, material, design, and complexity, including at least 2 years' supervisory experience directing and leading ICU/CCU entrance installers.

1.6 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.

1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
2. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items as shipped and in conformance with manufacturer's instructions and other requirements and recommendations for storage. Furnish adequate dunnage and bracing during storage.

1. Prevent stored items from contacting the floor or ground, from soiling and staining, and from deterioration and damage.
2. If items are not stored in an enclosed location, then cover the tops and sides with securely-tied, waterproof, and breathable covers. Unvented polyethylene tarpaulins do not qualify as breathable covers and are prohibited. (due to potential accumulation of moisture beneath tarpaulin during certain environmental conditions)
3. Incline covered items to ensure maximum drainage of accumulated moisture.
4. Do not leave items uncovered where they might be exposed to weather or become wet; or exposed to other sources of deterioration and damage.

C. Handling: Handle items in conformance with manufacturer's instructions and other requirements and recommendations, and in a manner that that prevents damage.

D. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective ICU/CCU entrances with undamaged new ICU/CCU entrances that do not exhibit deterioration, damage, or defects.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

1.7 WARRANTY

A. Manufacturer Warranty: Furnish to the Owner a written manufacturer warranty for products, components, and accessories against all patent and latent defects, and incipient and catastrophic failure for 5 years.

B. Installer Guarantee: Furnish to the Owner a written guarantee for the work of this specification section against all defects in materials and workmanship for 2 years from date of acceptance. Guarantees must be properly prepared and signed on the guarantee form in Division 01.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer: Provide products manufactured by one of the following, or equal.
   1. ASSA ABLOY Entrance Systems.
   2. Horton Automatics.

2.2 ICU/CCU ENTRANCES

A. Single Slide Entrances:
   1. Product: “Profiler-ICU” (Type 010) manufactured by Horton Automatics, or equal.
   2. Requisite Properties:
      a. Configuration: Single-sliding two-panel door, with one operable leaf and sidelight.
      b. Unit Width: 8 feet, 6 inches.
      c. Minimum Clear Door Opening Width: 3 feet, 9 inches.
      d. Mounting: Overhead header installed between jambs.
      e. Finger Safety: When sliding open, strike rail of sliding panel will stop 3-1/2 inches short of adjacent sidelight.

B. Single Slide, Full Breakout Entrances:
   1. Product: “Profiler-ICU Trackless” (Type 310T) manufactured by Horton Automatics, or equal.
   2. Requisite Properties:
      a. Configuration: Single-telescoping three-panel door, with two operable leaves and one sidelight; with breakaway capability for sliding leaves and sidelight.
      b. Unit Width: 7 feet, 0 inches.
      c. Minimum Clear Door Opening Width: 3 feet, 9 inches.

d. Trackless Design: Floor mounted guide track and threshold not allowed.
e. Breakaway Capability: Sliding leaf and sidelight unit when door is at full open position.
f. Mounting: Overhead header installed between jambs.

C. Requisite Properties:
1. Faming Size: Nominal 1-3/4 inches by 4 inches.
2. Glazing Nominal Thickness: One-inch.
3. Exposed Finishes: Match storefront framing.
4. Concealed Steel Finishes: Prepare surfaces and apply shop primer.
5. Concealed Aluminum Finishes: Prepare surfaces and coat surfaces in contact with masonry, concrete, or steel with bituminous paint specified Section 05 50 10.

2.3 MATERIALS

A. Aluminum:
1. Standard Aluminum Structural Profiles: ASTM B 308, Alloy 6061-T6.
2. Extruded Aluminum Bars and Shapes: ASTM B 221, Alloy6063-T5 or T6 for primary components; Alloy 6063-T5 or T6, 6005-T5, 6105-T5 or 6061-T6 for structural components.
3. Aluminum Sheet and Plate: ASTM B 209, Alloy 5005-H32 or Alloy 3003-H14.
4. Extruded Aluminum Tubes: ASTM B 221 or ASTM B 483.
5. Structural Aluminum Pipe and Round Tube: ASTM B 429.

B. Glazing: 6.0mm thick (nominal 1/4-inch) tempered glass, unless otherwise indicated.

2.4 ACCESSORIES

A. Hardware: Manufacturer's standard factory-installed operating hardware, finish must match adjacent door hardware.

B. Glazing Gaskets: Manufacturer’s standard ethylene propylene diene monomer (EPDM) conforming to ASTM C 864 and having a Shore A hardness value of at least 70, unless another type of gasket is supplied, required, recommended, or accepted by the manufacturer.

C. Brackets: Provide high-strength aluminum or non-magnetic austenitic stainless steel brackets and reinforcements.

D. Fastenings: Provide backings, inserts, loose connection hardware, fasteners, anchors, attachments, connectors, and other items supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.
1. Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.

2. Reinforce framing members as required to receive fastener threads.
3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.

E. Other Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification: Verify in-place supporting and adjacent construction conforms to the manufacturer's requirements or recommendations and satisfies all other conditions that might affect the quality of installation or the durability, appearance, or performance of installed and adjacent items.

C. Evaluation and Assessment:
1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.
2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 INSTALLATION

A. General Requirements:
1. Install ICU/CCU entrances using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
2. Set items true to line, to required levels and lines, and plumb, level, and square, without warp or rack, with flush well-fitted joints, and in alignment with adjacent construction
3. Installed ICU/CCU entrances must be warrantable. Do not install, correct, or replace ICU/CCU entrances in a manner that results in any warranty or guarantee becoming void.

B. Special Techniques:

1. Use concealed fasteners and anchorages. Provide washer head fasteners with bonded sealing washers where required to protect metal surfaces and to make weathertight connections.
2. Form closely-fitted joints with exposed connections accurately located and secured.
3. Provide uniform-width perimeter reveals and opening sealants and joint fillers as indicated.
4. Install concealed gaskets, flashings, and joint fillers as the ICU/CCU entrance installation progresses.

C. Interface with Adjacent Items: Provide materials, components, and accessories normally furnished or necessary to securely attach ICU/CCU entrances to supporting construction.

D. Installation Tolerances: Install ICU/CCU entrances to an allowable tolerance variation of not more than 1/4-inch from true position and not more than 1/8-inch from plumb, level, and alignment.

3.3 ADJUSTING

A. Verify smooth and quiet ICU/CCU entrance and hardware operation.

B. Lubricate and adjust operating parts and hardware to function properly, free from warp, twist, binding, and distortion. Confirm latches and locks engage securely without forcing or binding.

C. Replace items that do not operate freely in a safe and reliable manner.

3.4 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
1. written descriptions of non-conforming, damaged, and defective work;
2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.5 CLEANING

A. Cleaning Work: Clean all visible ICU/CCU entrance surfaces in a manner that does not result in any warranty or guarantee becoming void.
   1. Use cleaning materials, equipment, and accessories supplied, and means, methods, techniques, and procedures required, recommended, or accepted by the manufacturer.
   2. Do not use cleaning materials or procedures known to change, or that might change, the appearance of exposed finishes or adjacent surfaces; or cause deterioration or damage to exposed finishes or adjacent surfaces.
   3. Protect adjacent surfaces not being cleaned from staining, deterioration, damage, or other detrimental effects caused by cleaning.
   4. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be cleaned to the Architect's acceptance.

B. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

3.6 PROTECTION

A. Protect installed ICU/CCU entrances in place from soiling, deterioration, and damage until Substantial Completion.

B. Do not store anything adjacent to or against installed ICU/CCU entrances unless they are protected from damage, as accepted in writing by the manufacturer's representative. Do not use installed ICU/CCU entrances as work surfaces.

C. Remove protection when it's no longer needed and before Substantial Completion.

END OF SECTION

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SECTION 08 71 00 - DOOR HARDWARE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. BHMA finish door hardware for doors.

1.2 PRODUCTS SUPPLIED BUT NOT INSTALLED UNDER THIS SECTION

A. Hardware templates for doors and frames.

1.3 RELATED SECTIONS

A. Summary of Work: Division 01, applicable Sections, including but not limited to:

B. Masonry: Division 04, applicable Sections.

C. Carpentry: Division 06, applicable Sections (Section 06 10 00 Rough Carpentry).

D. Perimeter Sealants and Insulation: Division 07, applicable Sections.

E. Division 08, applicable Sections including, but not limited to, Wood Doors; Hollow Metal Doors and/or Frames; Storefront; Aluminum Doors and/or Aluminum Frames; Sliding Glass or Framed Doors; All-Glass Doors.
   1. Section 08 17 13 – Integrated Door Assemblies.
   2. Section 08 71 13 – Automatic Door Operators.

F. Divisions 26 through 28: Electrical rough in, wiring and connectors for electrified hardware including, but not limited to:
   1. Wire and connectivity from ceiling through frame to electrified hardware devices including non-Section 08 71 00 task of providing wiring inside of doors.
   2. Section 08 71 13 “Automatic Door Operators” including Automatic Door Operators e-power or emergency power connectivity scope at exterior doors (provide emergency power backup for auto operators).

1.4 PRODUCTS SUPPLIED BUT NOT INSTALLED UNDER THIS SECTION

A. Hardware templates for doors and frames.

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1.5 REFERENCES

A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only.
   1. Refer to Division 01 for definitions, acronyms, and abbreviations.
   2. Unless otherwise noted; standards, manuals, and codes refer to the latest edition as of the issue date of this Project Manual.

B. Conform to the following Referenced Standards and Requirements:
   1. CBC – 2022 California Building Code.
   2. ADA – Americans with Disabilities Act - 2010 Standards for Accessible Design.
   3. ANSI/BHMA 156.19 American National Standard for power high and low energy operated doors.
   4. ANSI A156 Series – Builders Hardware Manufacturers Association (BHMA) Standards Set.
   5. AAADM – American Association of Automatic Door Manufacturers.
   6. California State Fire Marshal Fire Door Assembly Tests Standard 12-7-4:
      a. Smoke-rated and fire-rated doors and frames shall meet UL rated assembly requirements.
      b. Manufacturers of UL rated assemblies and devices shall provide documentation that assemblies have been tested and comply with California State Fire Marshall, Fire Door Assembly Tests/Standards #12-7-4 and shall be installed accordingly.

1.6 QUALITY ASSURANCE

A. Supplier Qualifications and Documentation:
   1. Hardware Supplier Qualifications: Firm specializing in the supply and servicing of institutional and commercial door hardware; accredited by manufacturers; and having a minimum of three years documented experience. Hardware supplier to furnish list of at least ten past, finished projects. Include date competed, project location, and references.

B. Manufacturer of Submitted Devices - Qualifications and Documentation:
   1. Manufacturer Qualifications: Manufacturer specializing in manufacturing institutional and commercial door hardware with a minimum five years with the following documented experience. Furnish list of at least ten past, finished projects. Include date competed, project location, and references. Past project contact information will determine if Builders Hardware is acceptable.

C. Installer of Submitted Devices - Qualifications and Documentation:
   1. Installer of assembly shall be trained in the trade of hanging commercial doors on commercial frames with commercial hardware. Supplier and Installer of door assemblies shall be authorized representative of manufacturers and have minimum of five years successful experience in detailing, supplying, and installing door assemblies specified on projects of similar size, complexity, and type to this Project.

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Provide written documentation to show closers will be installed by an individual with successful experience installing closers to meet 5-pound opening force for non-rated door complexity.

1.7 SUBMITTALS

A. The hardware groups/sets specified in Section 08 71 00 - Part 3 are intended to establish type and design standard when used together with the requirements of this Section, Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections. Examine Contract Documents and furnish proper hardware for door openings. Refer to specifications for clarification and detailed requirements and provide products and services in specifications even if not written in hardware groups/sets in Section 08 71 00 - Part 3.

B. For each opening submit coordinated (means and methods) requirements in accordance with Division 01 and a detailed door, frame and hardware schedule. See pre-hardware and hardware scheduling requirements below. Submittals that do not meet means and methods, including missing related doors/frames submittal/shop drawings, will be returned for correction before checking.

C. LEED Submittals:
1. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include achieving LEED v4 Certification. Refer to Section 01 81 13 "Sustainable Design Requirements" for the Project's target certification level and specific LEED requirements. The Contractor shall ensure that the requirements related to the Project's sustainability design goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project's sustainability goals and LEED certification.
2. EPD/LCA Documentation: Provide a publicly available Environmental Product Declaration in conformance with standards listed and described in Section 01 81 13 "Sustainable Design Requirements."
3. Manufacturer Take-back Documentation: Provide documentation of the manufacturer's take-back program as defined in Section 01 81 13 "Sustainable Design Requirements."
4. Regional Sourcing Documentation: Provide a product data sheet or manufacturer affidavit demonstrating regional sourcing as defined in Section 01 81 13 "Sustainable Design Requirements."
5. Recycled Content Documentation: Provide a product data sheet or manufacturer affidavit noting the pre-consumer (post-industrial) and post-consumer recycled content value of the product or product components in accordance with requirements described in Section 01 81 13 "Sustainable Design Requirements."

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D. Pre-Hardware Scheduling Tasks:
   1. Coordinate work of this Section with other directly affected Sections and scope.
   2. Provide required Division 08, means and method type work in accordance with Contract Documents at no additional cost to project, including Division 01 and language below. This Section supplier shall be provided with full documents, not just Section 08 71 00 Part 3 hardware group/sets as that process does not meet Contract requirements.
   3. Means and method type work includes, but is not limited to, coordination with plans and other specifications, templating, Section 08 71 00, and other Division 08 Section engineering and coordination. Starting submittal work or labor before means and method type work is completed does not constitute change orders.
   4. Provide RFIs (request for information) for clarification items before submittals. This Section is not to be a stand-alone submittal but requires multiple Sections and Drawings coordination before submittals will be reviewed.
      a. Coordinate length and sizes for hardware devices before submittals, Verify the door hardware is compatible for use with the doors and door/frames.
      b. Report all prevailing conditions that will adversely affect satisfactory execution of work before submittals.
         1) Example 1: If door stiles would inhibit the use of specified hardware, provide RFIs before starting detailed hardware headings or group submittal process.
         2) Example 2: Coordinate length and sizes for hardware devices before ordering materials (verify the door hardware is compatible for use with the doors and/or door/frames) included, but not limited to special templates and sizes of devices.
      c. This Section clarification items (RFIs) shall be reviewed by a non-design team coordinator before sending to design team for review.
         1) For clarification items that are means and methods (directed to or from one vendor to another vendor, framer/installer), Contractor shall coordinate and answer or list questions that are not design scope.
   5. Multiple submittals for this Section work will not meet Contract requirements. Exceptions are as follows:
      a. Submittals may be broken up into different door vendor packages (for example: one glazing vendor package, one hollow metal and wood door vendor package, one auto operator vendor), but breaking each of these packages into multiple or separate packages is not permissible (example: separate project buildings or different floors broken out not permitted).
      b. Frames that are required to be ordered early in the build process (under ten frames / openings required to meet project deadlines for early site work) may be broken into separate packages but remaining hardware in these packages will be rejected and not reviewed.
   6. Coordinate with door/frame internal reinforcement for door hardware. In particular, coordinate door preparation in accordance with applicable regulatory and trade standards specified.

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7. Coordinate keying requirements with all openings with one Vendor. For keying scope, even if different Section door/frame scope packages are submitted with different hardware schedule submittals, only one Section 08 71 00 supplier is to oversee, coordinate, submit, furnish, and install keying. Coordinate per Section 08 71 00 and per means and methods before submits begin.
8. To detail submittals and nomenclature for electrified hardware, review and coordinate electrical specifications and drawings for scope that could affect hardware selections:
   a. Scope includes, but not limited to, auto operator locations if related to project and/or access control if related to project and/or electrical Divisions 25-28 and applicable Drawings.
   b. For electrified hardware interface with non-Division 08 access control or electrified tasks, the non-Division 08 access control or security vendor task shall provide a written agenda/plan how access control or security scope will be installed for a complete and operational system. Written agenda shall include power requirements and additional relays at no additional cost.
   c. For electrified hardware interface with non-Section 08 71 00 auto operator devices, the Section 08 71 13 auto operator vendor task shall provide a written agenda and plan how auto operator scope will be installed for a complete and operational system. Written agenda shall include power requirements and additional relays at no additional cost.
   d. Division 08 vendor and/or installer is not responsible for electrical wiring or FLS (fire/life safety) connectivity to above frame or back-of-house systems, but per Code in event of FLS alarm or loss of building power, at fire and smoke rated opening electrified strikes, auto operators, fail-safe levers, and electro-magnetic devices shall become non-electrified (drop power so doors can close, positive latch, and to be only manually operated). Electrified fail-secure levers are not required to be coordinated with FLS system; acceptable to have power to fail-secure in FLS events.

E. Hardware Schedule:
   1. Submit required vendor qualification letters and documentation (see above "QUALITY ASSURANCE").
   2. Non-design team coordination and requirements:
      a. Submittals for coordinated door/frame/hardware items, shall be submitted at the same time for review of total opening requirements. Do not submit Section 08 71 00 scope without coordinated door and frame packages and above RFI/clarification process tasks completed. Submittals that do not include related doors/frames will be returned for correction before checking.
      b. Section submittals and/or shop drawings to be reviewed and have comments by non-design team (Contractor) before sending to design team. If submittals do not meet Contract requirements, return to hardware vendor for re-submittal. In many cases, unacceptable submittals are passed though without non-design team (Contractor) comments (coordinate per Contract).

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3. Submit hard copies of hardware schedule (number of copies per Division 01) as well as submit editable, PDF files via electronic email or ftp site process in Vertical Format as illustrated by the Sequence of Format for the Hardware Schedule as published by the Door and Hardware Institute. Horizontal-type schedules will be returned for correction before reviewing.
   a. Shop drawings / hardware schedule shall clearly indicate each hardware group specified and manufacturer of each item proposed as well as each door number that the hardware is assigned to.
   b. Contractor is responsible for handing and sizing all products.
      1) Coordinate and show length and sizes for hardware devices before submittals (verify the door hardware is compatible for use with the doors & door/frames). Examples include but are not limited to the widths of panic devices and other devices that change in size due to door width and height at times (means and method type work, engineering, templating, coordination).
      2) Handing of doors is to be done per the plan view. The designer/architect reviewers are not responsible for wrongly handed doors when they arrive in the field. Provide correct handing and swing of doors as openings/doors are shown on drawings, plan view and security plans. Keyed-side or card reader side determines handing (keyed door typically will be from the non-egress side of the opening - - - if only one door in the rooms, this door is to be free egress, no locking of interior lever). RFI if other doors are in question for which side of the door is to be keyed.
   c. Vertical schedule format sample:

Heading Number 1 (Door Schedule or Architectural Assigned Hardware Group/Set number from part 3 = HW #__)				
1 Single Door #1 - Exterior from Corridor 101	Opening Size	90°	RH	Rating
Quantity	Device Description	Device # (include specification language)	Finish	Manu-facturer
4	Hinges	5BB1HW 4.5 x 4.5 NRP x fasteners	630	IVES
1	Lockset			
1	Best Cylinder (SFIC)	1E72 or 1E74 appropriate cam x blocking rings as required (rim or mortise type & quantity as required by locking device)	626	BE
1	Permanent Core	1C7 x Patented Keyway per owner's requirement	626	BE
1	Stop and Holder	1261	626	TR
1	Door Silencers	1229A or 1229B (as required)	GR	TR

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4. Illustrations from manufacturer's catalogs and product data:
   a. Provide cut sheets and product data with vertical format hardware submittal (same timeframe) as well as door and frame information to be reviewed as one submittal package. Manufacturer's hard copy as well as PDF catalog cut sheets and product data shall not be submitted before editable, PDF files vertical format hardware submittal. See above Sequence of Format requirement. Catalog cut sheets and product data sent as submittals before the typed out nomenclature of hardware part numbers (vertical format hardware submittal) will be returned without review.
5. Provide hardware schedule and hardware templates to door and frame manufacturer. Provide two templates to those manufacturers who are not currently registered template book holders.
6. Wiring Information: Provide manufacturers' wiring information including manufacturers' door elevation diagrams for electrified hardware based on Door Hardware Institute (DHI) core class "Electrified Architectural Hardware" DHI class #COR133. Openings where only magnetic hold-opens or door position switches are specified do not require wiring information. Provide information with hardware schedule submittal for review. Provide detailed wiring diagrams with hardware delivery to jobsite.

F. Vendor meetings or coordination prior to purchasing materials:
1. Convene coordination meeting between all opening vendors and installers at least two weeks prior to purchasing doors, frames, door hardware, and electrical devices required for complete systems. Attendance includes but is not limited to hardware supplier and/or installer, door supplier and/or installer, frame supplier and/or installer, auto operator vendor and/or installer, security card reader vendor and/or installer, and electrical. If hardware changes are required due to these meetings, communicate changes to design team before ordering materials.

G. Templates:
1. Provide listing of manufacturer's template numbers for each item of hardware in hardware schedule.
2. Submit templates and "Reviewed Hardware Schedule" to door and frame supplier and others as applicable to enable proper and accurate sizing and locations of cutouts and reinforcing.

H. Installation Instructions:
1. Provide manufacturer's written installation and adjustment instructions for finish hardware.
2. Send installation instructions to site with hardware.

I. Contract Closeout Submittals: Include specific requirements indicated below.
1. Operating and maintenance manuals: Submit three sets containing the following:
   a. Complete information in care, maintenance, and adjustment, data on repair and replacement parts, and information on preservation of finishes.
   b. Catalog pages for each product.

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c. Name, address, and phone number of local representative for each manufacturer.
d. Parts list for each product.
e. Copy of final accepted hardware schedule, edited to reflect "As installed".
f. Copy of final keying schedule.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of Division 01.

B. Deliver products in manufacturer's original containers, dry and undamaged, with seals and labels intact.

C. Storage: Store materials in a cool and dry location, elevated from the ground and protected from the elements, and secured from theft or pilferage.

1.9 WARRANTY

A. Comply with provisions of Division 01.

1.10 MAINTENANCE

A. Provide special wrenches and tools applicable to each special hardware component.

B. Provide maintenance tools and accessories supplied by hardware manufacturer.

PART 2 PRODUCTS

2.1 FINISH

A. Typical BHMA finish designation references:
1. Typical BHMA finish designation references:
a. BHMA 630 – satin stainless steel.
b. BHMA 626 – satin chromium plated brass or bronze.
c. BHMA 652 – Satin or dull chromium plated steel.
d. BHMA 628 – satin or dull aluminum, clear anodized (uncoated).
2. Closers (electrified, hold-open device):
a. BHMA 689 – Sprayed aluminum paint finish (back of house where specified).
3. Antimicrobial Finish designation references:
a. BHMA 710CU Healthy Hardware™ Antimicrobial Finish.
b. Allegion BHMA 626MA or 630MA Antimicrobial Finish

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c. Antimicrobial Finish nomenclature in hardware groups/sets shall be finished with "Antimicrobial Finish," an FDA recognized antimicrobial coating with built in protection to prevent the growth of a broad range of bacteria, mold, and mildew. Provide full warranty of locking manufacturer and push pull devices in 630 and 626 finishes with added antimicrobial finish.

2.2 HARDWARE TEMPLATE

A. Make templates for hardware to be applied to metal doors or pre-finished doors.

B. Hinge templates shall conform to ANSI A156.7.

C. Promptly furnish template information or templates to door and frame manufacturers.

D. Coordinate hardware items to prevent interference with each other.

2.3 FIRE RATED DOORS AND EXIT DOORS

A. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on drawings and detailed requirements for each type of device. Provide all specifications even if not written in hardware sets/groups.

B. Provide all hardware necessary to meet the requirements of CBC for fire doors and exit doors, as well as to other requirements specified, even if such hardware is not specifically mentioned under Article "Hardware Schedule" of this Section.

2.4 SCREWS, BOLTS, AND FASTENING DEVICES

A. All exposed fasteners to be stainless steel or zinc plated.

B. Exposed head oval Phillips type screws in countersunk holes unless otherwise specified.

1. Use screws, bolts, washers, grommets, nuts, and other fastening devices of appropriate length, type, head, metal, and finish as necessary for proper match and application of hardware.
2. For all protection plates (armor-plates, kick-plates and mop-plates) provide smooth, unobstructed surface with counter sunk fasteners with no sharp edges or an approved adhesive per below (no raised fasteners allowed).
    a. 3M adhesive #4032 that includes in its testing the following: Double coated polyurethane foam adhesive:.
        1) Foam Density: 20 lb/ft^3.
        2) Tensile Strength: 240lbs/ in^2.
        3) Elongation at Break: 90%.
        4) Short temperature resistance: 380 °F.

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5) Dielectric Strength: 8 to 21 V/µm.

6) Thermal Conductivity: 0.062 W/m/K.

b. In addition to UL testing standard testing practices the 3M adhesive when used with protection plates shall have gone through Thermogravimetric Analysis and Fourier Transform Infrared (FT-IR) Spectroscopy.

C. Closer and exit/panic devices:

1. Install using concealed fasteners. Where there is insufficient blocking in the door or reinforcement in the door and/or frames (see related Sections as design should have blocking in the door or reinforcement in the door and/or frames) utilize through bolts or SNB devices.

D. Threshold anchors shall be Flat Sleeve Anchors cadmium plated expansion anchor screw in one unit.

2.5 LEAD LINED APPLICATIONS

A. Provide all hardware necessary to meet the requirements for lead lined applications. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device. Provide all specifications even if not written in hardware sets/groups.

1. Lead Protection: Lead wrap hardware penetrating lead-lined doors.
2. Levers and roses shall be lead lined.
3. Apply kick and armor plates with 3M adhesive #4032, as recommended by 3M Co., on lead-lined doors.
4. Coordinate devices including, but not limited to, closer and/or overhead stop applications so that lead-lined door will have no penetration in lead. Through bolts shall be lead lined to meet application requirements.

2.6 SUBSTITUTIONS

A. Products referenced by specific brand names and model numbers have been identified by Owner to match other products in use either completed or in the course of completion. No substitutions permitted per Public Contract Code Section 3400.

1. Otherwise refer to Division 01 for substitutions.

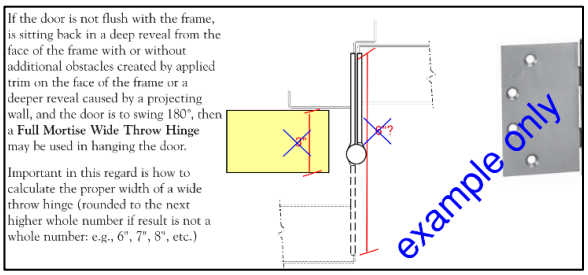
2.7 HANGING HARDWARE

A. Butt Hinges:

1. Acceptable Manufacturers:
   a. McKinney Products Co.
   b. Ives Manufacturing by Allegion.
   c. Hager Manufacturing.

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2. Where hardware groups/sets have different information (number of hinges and sizing), refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device.
   a. Butt hinges shall be manufactured in accordance with ANSI/BHMA A156.1.
   b. Self-closing hinges and pivots shall be manufactured in accordance with ANSI/BHMA A156.17.
   c. Provide wide throw hinges where required:
      1) Whether new or existing openings (existing doors or frames to remain), submit and provide hinge widths sufficient to clear trim projection when door swings 180 degrees. All doors shall swing 180 degrees if wall allows.



      2) Utilize wide throw type hinges to clear frame or wall obstructions/cladding in order for doors to completely open. See 180-degree language above.
      3) Where a door closer device is specified and will be installed on pull side/hinged side of doors (i.e. closers will hit walls or other surfaces when door is completely open), provide wide throw type hinges to give sufficient pocket depth to hide closer behind door. Do not pinch or crush closer between the door and wall surface.
      4) Confirm hinge sizing with frame and wall details.
   d. Provide "weight/strength" as specified in hardware groups/sets in Part 3 (hinge nomenclature basis-of-design weight/strength).
   e. For doors 1-3/4 inches thick and up to 36 inches wide, provide hinge height of 4-1/2 inches.
   f. For doors 1-3/4 inches thick and 37 inches to 48 inches wide, provide heavy duty, four ball bearing hinges and height of 5 inches.
   g. If hardware sets specify height (example: 5 inches tall at 36 inch wide door), provide height as specified for project standards at these locations.
   h. Provide two butts for doors up to 60 inches high and one additional butt for each 30 inches of height or fraction thereof.
   i. Provide non-removable pins at exterior doors.

B. Continuous Hinges:
   1. Acceptable Aluminum and Stainless-Steel Manufacturers:
      a. Markar Manufacturing.
      b. Ives Manufacturing by Allegion.
      c. Select Hinges.

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2. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device:
    a. Provide widths sufficient to clear trim projection when door swings 180 degrees. Confirm hinge sizing with frame details. All doors shall swing 180 degrees if opening will allow. Provide wide throw hinges where required.
    b. Provide continuous hinge that meet cycle testing in accordance with ANSI/BHMA Standard A156.26, Grade 1.
    c. Stainless steel hinges shall meet abuse test per ASTM F1450.
    d. Aluminum material: Extruded tempered aluminum. Material Standard: 6063-T6 alloy. Configuration: Three interlocking extrusions in pinless assembly, installed to full height of door frame.
    e. Continuous hinges shall not obscure fire rated labels of the doors or frames.
    f. Where indicated in hardware groups/ sets, provide continuous hinge with adjustable fasteners feature (basis of design and required: Markar part #M91-0005-630 Adjust-A-Screw, adjustable fasteners feature or accepted equal). See website as follows: http://www.markar.com/Other/Markar/PDFs/Tech%20memos%20new/1/Adjust-A-Screw%20Technical%20Memo%201.25.13.pdf.

2.8 SECURING DEVICES (LATCHING SYSTEMS)

A. Mortise Locksets, Latchsets, and Deadbolts:
1. Acceptable Manufacturers:
    a. BEST locks by Dorma manufacturing – 45H Series.
    b. Owner's standard, no substitutions permitted.
2. Levers:
    a. Provide levers to return to door within 1/2 inch.
3. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device:
    a. Locksets shall meet the requirements of ANSI/BHMA A156.13-1994, Operational Grade 1.
    b. Provide only thumbturn devices that meet accessibility requirements. No center pivoting thumbturns allowed.
    c. If deadbolts or lockbolts are utilized on the project, devices shall be interconnected with the latching mechanism on all doors to provide single movement function to unlatch doors.
    d. Backset: 2-3/4 inches. Provide minimum 1 inch throw stainless steel deadbolt Provide minimum 3/4 inch throw for latch bolt.
    e. Where indicated on Drawings, door schedule, or details provide lead lined devices.

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f. Strikes:
   1) Provide ANSI 4-7/8 inch standard strike.
   2) Provide curved lip-type strike at all locations if possible to prevent catching clothing or other objects on strike. Where required, provide detail and flat strike.
   3) Where required, provide extended lip strike so that the lock or latchset latch will not come in contact with frame or added trim on or adjacent to the frame. Example: Don Jo device #MEST-104, but provide submitted manufacturer equivalent extended lip strike.

B. Exit Devices:
   1. Acceptable Manufacturers:
      a. Von Duprin (Owner's standard unless Adams Rite are written to assist in meeting 44" clearance code in Part 3 hardware sets below – all others no substitutions permitted).
      b. Owner's standard, no substitutions permitted.
   2. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device:
      a. Exit devices shall be ANSI A156.3, Grade 1; UL Listed.
      b. All exit devices shall be UL listed for panic. Exit devices for labeled doors shall be UL listed as "Fire Exit Hardware".
      c. Provide cylinders for exit devices with locking trim and cylinder dogging. Provide cylinder dogging feature for non-rated exit devices.
      d. Whether or not specified throughout project, verify if Electrical, IDF and other rooms with electrical coordination have 800 amps or more than 800 amps housed within the rooms. At these rooms, if lever locksets are specified, credit the locking device and provide the Von Duprin mortise-type panic device #9975NL-F x 996L-M x key override.
      e. Trim:
         1) Where lever trim is specified, provide lever design to match lockset levers.
         2) Provide exit device lever trim with vandal resistant feature (heavy duty lever trim designed to with stand abuse and vandalism):
            a) Von Duprin 996 R/V.
      f. The unlatching force of panic hardware shall not exceed 5 pounds, applied in the direction of travel, certified by UL to meet requirements of CBC Section 11B-309.4 (Von Duprin nomenclature "AX").
   3. Provide panic devices complying with CBC Section 1010.2.9. The panic/exit device push-bar shall extend across no less than one-half the width of the doors.

C. Flush Bolts and Dust Proof Strikes:
   1. Acceptable Manufacturers:
      a. Triangle Brass Manufacturing Company, Inc. (Trimco).
      b. Rockwood.

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c. Hager Manufacturing.
d. Ives Manufacturing.

2. Where hardware groups/sets have different information, refer to the following for clarification. If door types have changed after the hardware in 08 71 00.Part 3 was written, utilize the following for submittal. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device:
   a. Non-rated Openings: Where not specified in hardware sets, provide two flush bolts for inactive leaf of pairs of locked and latched doors. Locate centerline of top bolt not more than 78 inches from finished floor. Provide dustproof strike for bottom bolts, type as required for floor condition.
   b. Rated Openings: Where not specified in hardware sets, provide automatic flush bolt set as applicable for inactive leaf of pairs of doors. Provide dustproof strike for bottom bolts, type as required for floor condition.
   c. At non-rated 20 minute rated wood doors or at all hollow metal doors provide either #3810 (metal doors) or #3815L (wood doors) as required per door material: For wood doors over 20 minutes in rating, provide top & bottom flushbolts #3815L x #3815L and dust proof strike device #3911. For metal doors over 20 minutes in rating, provide fire bolt #3850 (no bottom bolt or dust proof strike).

D. Coordinators:
   1. Manufacturers:
      a. Triangle Brass Manufacturing Company, Inc. (Trimco).
      b. Rockwood.
      c. Hager Manufacturing.
      d. Ives Manufacturing.
   2. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device:
      a. Provide coordinator for fire rated or smoke labeled pairs of doors equipped with automatic flush bolts and those with vertical rod/mortise lock fire exit device combinations with astragals.
      b. Provide filler bars for total opening width, closer mounting brackets to allow proper installation of stop mounted hardware without damaging coordinator, carry bars, and special preparation for top latches where applicable.

2.9 KEY SYSTEMS (CYLINDERS, CORES AND KEYS.)

A. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on drawings and detailed requirements for each type of device. Keying specifications below override hardware set/group nomenclature.

B. For all locking or dogging devices, provide complete cylinder system and coordination whether or not specified in Section 08 71 00, Part 3 hardware sets as required by locking device.
   1. Different locking devices require a set of different requirements including, but not limited to, appropriate cams for mortise-type cylinders, appropriate tail pieces and size for rim-type cylinders, blocking rings as required for locking and cylinder devices to not rattle and meet manufacturers' warranties, as well as cylinders that are to be coordinated with construction cores/cylinders and final pinned cores/cylinders shipped to Owner by Registered Mail per below to meet system requirements.
   2. Scope is means and method type work by a certified locksmith and/or DHI individual to engineer rim or mortise cylinders and blocking rings or tail-piece components as required for submitted locking devices. Since there could be as many as 500 options for rim or mortise cylinders with the locking devices and different manufactures that may be submitted, this means/methods-type work is required (similar to templating doors and frames to accept hardware). Coordinate as required.

C. Key Systems (Cylinders, Cores and Keys):
   1. Manufacturers:
      a. BEST locks by Dorma manufacturing.
      b. Owner's standard, no substitutions permitted.
   2. For all locking or dogging devices, provide complete keying system whether or not specified in Section 08 71 00, Part 3 hardware sets including lock cores, mortise cylinders, and rim cylinders keyed as directed by Owner in submittal process. Key System shall be:
      a. Patented BEST Cormax by Dorma manufacturing.
   3. Keyway: Provide as instructed by Owner during submittal process.

D. Keying Requirements:
   1. Provide keyed, construction cores and keys during the construction period.
      a. Provide full sized cylinders or brass construction cores and brass keys at all interior and exterior doors. Plastic cores are not permitted.
      b. Construction control and operating keys and core shall not be part of the Owner's permanent keying system or furnished in the same keyway or key section as the Owner's permanent keying system. Permanent cores and keys prepared according to the accepted keying schedule shall be furnished to the Owner.
   2. Keying Meeting and Programming Schedule:
      a. Do not provide keying matrix in original hardware submittals. After hardware has been submitted and reviewed in accordance with Division 01 and Section 08 71 00 requirements, arrange a keying matrix/programming meeting with Owner Representative and the project hardware suppliers/vendors that is certified to assist the Owner Representative in developing cylinders/keying system based on reviewed submittals per below (contract with a certified hardware suppliers/vendors/locksmith to perform the following tasks without the design

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team or design consultants input (keying meetings require confidentiality with no one outside these meetings knowing the city keying system).

1) Copies of all plans (pages with door numbers on them) shall be brought to the meeting with card reader and keyed doors highlighted for review (Contractor scope). After the meeting, provide the Owner Representative with both a scanned digital/PDF copy of the marked up plans, as well as the original copies of the plans delivered to the City with meeting notes.
2) Copies of all reviewed door, frame, and hardware submittals shall be brought to the meeting with card reader and keyed doors highlighted for review (do not use the original specifications for keying meeting). After the meeting, provide the Owner Representative with both a scanned digital/PDF copy of any hardware submittal pages that have mark ups, as well as the original copies of the meeting's hardware submittal pages delivered to the Owner's Representative with meeting notes.
3) Follow procedures for keying meeting and programming schedule as outlined by the Door Hardware Institute. DHI procedures are based on Door Hardware Institute core class entitled Masterkeying class #AHC200.

b. Keying meeting to produce a programming schedule/matrix based on the following:
   1) Furnish keys in the following quantities (total quantity of keys part of bid package):
      a) 5 each Grand master-keys per set.
      b) 6 each Masterkeys per set.
      c) 3 each Change keys each lock, core or cylinder.
      d) 5 each Permanent Extractor keys.
      e) 9 each Construction masterkeys.
      f) 2 each Construction Core Extractor keys.
   2) Provide keying system expansion parameters.
      a) Plan twenty changes directly under the grand.
      b) Plan ten master keys.
      c) Plan fifty changes each for each master.
   3) Permanent keys and cores shall be stamped with the applicable key mark for identification. The visual key control marks or codes shall not include the actual key cuts.
   4) Permanent keys shall be stamped "Do Not Duplicate".
c. Furnish typed programming meeting notes in PDF, editable electronic format as well as mailed, hard copy to Owner Representative (see above required PDF and hard-copy requirements).
d. Transmit pinned cores/cylinders as well as cut grand masterkeys, masterkeys, change keys and other security keys to Owner Representative by Registered Mail, return receipt requested. All permanent cores and keys shall be sent directly from the factory to the Owner Representative for ID and verification.

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3. Accompany Owner Representative to install permanent cylinders and/or cores:
   a. In above keying meeting, plan time to accompany Owner Representative/assist the installation process of permanent cores in contracted permanent locking or keying housings.
   b. Owner Representative and Contractor to agree on timeline when Owner Representative will have their completed pinned cores ready for installation.
   c. Contractor responsible to prepare locking systems, installation ready for final cores, free from dirt, debris or overtightening of locking devices that my cause binding of keyed devices).
   d. On project walk to assist in permanent core install, Contractor responsible to un-install construction cores (construction core devices are Contractor purchased and Contractor could keep or dispose of non-security construction cores).
   e. Provide instructions for adjustments and maintenance of hardware and hardware finishes.

2.10 CLOSING DEVICES

A. Surface Mounted Closers:
   1. Rack and Pinion Manufacturers:
      a. LCN Manufacturing: 4040XP Series as scheduled.
      b. Owner's standard, no substitutions permitted.

B. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device:
   1. ANSI A156.4, Grade 1; UL Listed; meets UL 10C and SFM Standard 12-7-4 for positive pressure fire test. Whether or not specified in hardware groups/sets, submit 4040XP at all openings that are smoke-rated or fire-rated even if closer is omitted from groups/sets.
   2. Closers shall have multi-size spring power adjustment to permit setting of spring from 1 through 6 with additional spring power available. Provide ADA compliant setting nomenclature during submittals as recommended by closer manufacturer.
   3. Submit correct closer type as to be able to install closers on non–public side of doors (examples include but are not limited to 1) interior side of storage/electrical type rooms; 2) not in corridors/public areas 3) stair side of stairway doors; and at exterior locations, install closers inside of building (in conditioned spaces)).
   4. Installation Plates, Brackets, and Miscellaneous Adapters:
      a. Provide drop plates, brackets, or adapters for arms as required to suit details and install as directed by manufacturer's templates.
         1) Furnish and install drop plates at reverse bevel doors and at doors with 170 degrees to 180 degrees swing.

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2) Furnish and install blade, angle or applied stops as required where frame does not permit installation of the standard soffit plate (see example LCN #419 Flush Panel Adapter to be shown in submittals below). If LCN manufacturer #419 Flush Panel Adapter is not in submittals as required for transom panel applications or if other drop plates, blade, angle or applied stops are not in submittals the submittal will be marked revise and resubmit. After doors are installed, hardware Vendor to field verify additional brackets and shims required before installing closers. Provide written language in submittals for how areas requiring special applications will be installed.

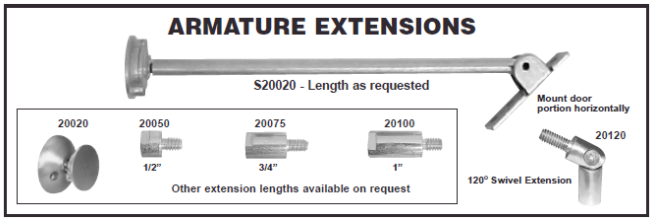
2.11 STOPS AND HOLDERS

A. Overhead Door Holder/Stops:
   1. Acceptable Manufacturers:
      a. Rixson Manufacturing.
      b. ABH Manufacturing.
      c. Glynn Johnson.
   2. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device.
      a. Overhead Stops and/or Holders shall meet the requirements of BHMA A156.8, Type 1, Grade 1.
      b. If overhead stops are specified in hardware groups/sets, do not provide wall or floor stops as alternative method of stopping door.
      c. If manual overhead “stop and hold-open” type devices are specified on fire-rated doors, provide the non-hold open function at time of submittals. Manual hold opens not allowed on fire rated doors.

B. Floor and Wall Door Stops/Holders and Bumpers:
   1. Acceptable Manufacturers:
      a. Triangle Brass Manufacturing Company, Inc. (Trimco).
      b. Ives Manufacturing.
      c. Rockwood.
      d. Hager Manufacturing.
   2. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device:
      a. Stops, Bumpers and/or Holders shall meet the requirements of BHMA A156.16, Grade 1.
      b. Coordinate with specifications in Division 05, 06, and/or 09 for required wall backing.

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C. Magnetic Door Holders:
   1. Acceptable Manufacturers:
      a. ABH Manufacturing.
      b. LCN Manufacturing.
      c. RSG Manufacturing
      d. Rixson Manufacturing.
   2. Coordinate with specifications in Division 05, 06, and/or 09 for required wall backing.
   3. Coordinate with Divisions 25-28 for electrical work.
      a. Description of Operation: When door is placed in opened position, magnetic holder shall automatically engage hold open mechanism (magnet).
      b. Door releases hold open and fully closes door by manual pulling of door or by the following, self-closing functions: 1) Close on fire alarm activation. Verify voltage and coordinate integration with fire alarm system; or 2) Close due to loss of power. Coordinate integration with local power system.
   4. At all locations utilizing hold open magnetic devices provide correct armature length for doors (example of armature lengths in snippet/picture below).
      a. Where doors will open 90 degrees or 180 degrees, swing parallel or against adjacent wall provide length required to make door 90 degree or 180 degree preferred in open position.
      b. At conditions where doors open between 90 degrees and 180 degrees, provide armature arm application and length so that door will reach wall condition and hold doors open until fire or other alarms drop power and close doors automatically.
      c. Hinge and closer coordination is required for doors that swing more than 90 degrees. Provide wide throw type hinges to clear all frame or wall obstructions in order for doors to fully open and to hide closer behind door when door are flat against a wall.



2.12 ACCESSORIES

A. Kick/Mop Plates:
   1. Acceptable Manufacturers:
      a. Triangle Brass Manufacturing Company, Inc. (Trimco).
      b. Ives Manufacturing.
      c. Rockwood.
      d. Hager Manufacturing.

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B. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device.
   1. Coordinate length and sizes for hardware devices before ordering materials (verify the door hardware is compatible for use with the doors and door/frames). Protection plate example: LDW nomenclature in Part 3 means "less door width". A 48-inch wide door would have a 46 inch wide protection plate. Width shall be one inch less than door width unless doors have protective edge guards or center mullions. Coordinate before submittals.
   2. At rated doors (UL smoke or fire), furnish protection plates with engraved UL listing information. Example: Trimco added part #ULS added to all kickplates specified below that are on UL or rated doors/openings.

C. Push/Pull Plates:
   1. Provide pulls at specified doors/openings. Where Trimco pulls are specified, provide request for substitution for matching pulls and/or pull manufactures (no film or applied antimicrobial coatings allowed, must be part of finish as scheduled)
   2. #Z100-20500 (older Trimco #1822) series installed face down and templated center hole for final cylinder and rings to be installed over #Z100-20500
   3. Acceptable manufacturers, if meeting specifications below (provide samples for review).
      a. Ives Manufacturing.
      b. Rockwood.
      c. Hager Manufacturing.

D. Smoke Seals, Intumescent Seals, Sound Seals:
   1. Acceptable Manufacturers:
      a. Pemko Manufacturing, Inc.
      b. National Guard Products (NGP).
      c. Zero International.
   2. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device:
      a. Where there are the material options for seals, the following is the order of preference for seals:
         1) Provide Silicone at all available location: Silicone preferred material for sustainability and cleaning options (bleach and alcohols).
         2) Neoprene material to be submitted where preferred Silicone cannot be submitted.
         3) Vinyl seals or seals made with vinyl material is not acceptable (vinyl is poor with cleaner types, and therefore should be avoided unless there is no alternate).

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3. No intumescent material is allowed on door frames. Where CBC requirements for positive pressure must be met, doors shall include all requirements as part of the door construction per 'Category A' guidelines as published by ITS/Warnock-Hersey. Only smoke gasketing applied around the perimeter of the frame to meet the 'S' smoke rating is permissible in instances where smoke control is required.

E. Light or Sound Seals:
   1. Acceptable Manufacturers:
      a. Pemko Manufacturing, Inc. Basis-of-Design: 29310CS or 350CSR adjustable seals.
      b. National Guard Products (NGP).
      c. Zero International.
   2. Where hardware groups/sets have different information, refer to the following for clarification. Provide hardware groups/sets devices along with added devices as indicated on Drawings and detailed requirements for each type of device:
      a. Where there is the material options for seals, the following is the order of preference for seals:
         1) Provide Silicone at all available location: Silicone preferred material for sustainability and cleaning options (bleach and alcohols).
         2) Neoprene material to be submitted where preferred Silicone cannot be submitted.
         3) Vinyl seals or seals made with vinyl material is not acceptable (vinyl is poor with cleaner types, and therefore should be avoided unless there is no alternate).
      b. In the field cutting or notching of sound gasket hardware shall not be permitted.
      c. Submit and supply STC type gasketing in lengths appropriate for template hardware. Examples below are not exhaustive; see hardware and door templating requirements.
         1) When rim-type exit/panic devices are used in conjunction with the STC type gasketing, order different lengths of STC type gasketing for latching side jamb to coordinate with -type exit/panic device, surface mounted latch. Do not install seal at roller-type latch location.
         2) When stop mounted overhead closer devices are used in conjunction with the STC type gasketing, provide the correct drop plates, brackets, and/or closer arms to not cut or notch the STC type gasketing. Provide full, header width of STC type gasketing. Example: If a parallel arm closer is utilized then provide offset arms like those used for surface mounted overhead stops, drop plates, and brackets. Example strike plate mounting bracket #770SPB by Zero International manufacturing or approved equal to coordinate with each different application.

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F. Astragals, Door Bottoms, and Thresholds:
   1. Acceptable Manufacturers:
      a. Pemko Manufacturing, Inc.
      b. National Guard Products (NGP).
      c. Zero International.
   2. Thresholds shall comply with CBC 2022 Section 11B-404.2.5 and shall not exceed 1/2 inch in height.
   3. Whether or not specified below in hardware sets, thresholds shall be detailed as part of engineering/shop drawings/means and methods before submittals.
      a. Thresholds that extend past door frame shall wrap frame stops. Cut around stops, then continue into rabbits, face of frame and wall conditions if wall conditions are in same application (see example of where threshold meet adjacent walls in snippet below):
      b. Whether or not specified below, where thresholds are larger than frames and/or extend past frames thresholds to have beveled miter ends. 45-degree miter cut and a closed end, welded with returns to door/frame. Example: NGP manufacturing nomenclature RCE throughout (see example snippet):

G. Drip Guard:
   1. Provide at exterior doors exposed to rain.
   2. Size: Full Frame Width (FFW).
   3. Provide devices painted to match adjacent frame. See Division 09 for paint and primer requirements.

2.13 POWER SUPPLIES, ELECTRIFIED HARDWARE, AND WIRES

A. Door Position Switches:
   1. Where hardware groups/sets have different information, refer to the following specifications for clarification and submit according to complete and intended electrified system per Contract Documents. See Architectural and Security drawings and specifications.
      a. Coordinate door and frame preparations with door and frame suppliers.
      b. Switches shall be installed in frame head approximately 4 inches from latching door edge. See security drawings for additional coordination.

B. Power Supplies, Wires, and Relays:
   1. Where hardware groups/sets have different information (number of hinge wires and power supply information), refer to the following specifications for clarification and submit according to complete and intended electrified system per Contract Documents. See Architectural and Security drawings and specifications.

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a. Coordinate use of power supplies with door and frame locations. Provide power supplies, relay, and battery backup units as part of the overall system in accordance with the manufacturer's warranty and system requirements. UL listed for applicable use; housed in an accepted enclosure; and provide both Class 1 and Class 2 outputs. At all doors with electric locking devices, if a power supply is not specified in the hardware set (Part 3 below), provide the following tasks and devices in pricing/cost (final to be selected and credit if required).

b. Except for Commend Access locking devices (see below for Commend Access power supplies), if there is not a power supply that can power the locking device, furnish and install #1) single gang power drop located above or near door (not in corridor or public view, but above celling line where possible); #2) provide power supply #PS902 (or for latch retraction #PS904 4 RL with 900-BB (battery backup for additional auto operator opening cycles when there is a power loss)) x Von Duprin/Schlage manufacturing; #3) run conduit from middle hinge through frame and complete wiring as required to meet manufacturer warranties (locks, hinges, and power supply manufacturer warranty). For all Von Duprin locations, Von Duprin updates their power supplies nomenclature often. Where hardware groups/sets have different information, refer to the following specifications for clarification. Verify with Von Duprin for correct power supply nomenclature and requirements per opening before submittals. Submit according to complete and intended electrified system.

c. Command Access: Furnish and install #1) single gang power drop located above or near door (not in corridor or public view, but above celling line where possible); #2) provide power supply #PS220 x Command Access manufacturing; #3) run conduit from middle hinge through frame and complete wiring as required to meet manufacturer warranties (locks, hinges, and power supply manufacturer warranty). For all Command Access locations, Command Access updates their power supplies nomenclature often. Where hardware groups/sets have different information, refer to the following specifications for clarification. Verify with Von Duprin for correct power supply nomenclature and requirements per opening before submittals. Submit according to complete and intended electrified system. If a battery back-up is required in the local power supplies for Command Access furnish and install #PS220B. This PS220B could power up to two locksets near each-other. Verify the correct power supply and furnish install as required and coordinated with Electrical and Security.

d. Output shall be filtered and regulated. Relay, timer, and logic modules shall be provided as required for interface to indicated security components, and shall be assembled, connected, and fully contained within the power supply enclosure.

e. Provide required connections to accommodate fire alarm/life safety system and/or security electronics for remote site monitoring of all electrified components and functions.

f. For all electric strike locations, provide HES "SmartPac III" In-Line Power Control or accepted equal product meeting specified requirements.

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PART 3 EXECUTION

3.1 EXAMINATION

A. Examine doors and frames and verify mounting locations as indicated on shop drawings.

B. Report unacceptable conditions to the Architect. Begin installation only when unacceptable conditions have been corrected.

3.2 INSTALLATION

A. Install in accordance with manufacturer's printed instructions and accepted shop drawings.

B. Door-Floor Clearances:
   1. Unless otherwise shown, provide the following door-floor clearances:
      a. Max 3/4" where no sill exists.
      b. Maximum 5/8 inch above raised sill/threshold.
   2. Undercut doors so that the sweeps still fit tight against the sill or threshold condition, but as the door opens and sweeps away from sill or threshold, the door bottoms do not rub on the floor. Metal installation parts of door bottoms are typically part of the door assembly and only the gap between the metal part and sill/threshold are seen as the undercut. Means and methods: coordinate as required for door and hardware with finish floors, toppings, thresholds and performance ratings.

C. Hardware Placement:
   1. Unless otherwise shown or required by CBC 2022, ADA Act - 2010 Standards for Accessible Design and/or Title 24, place hardware at the following heights:
      a. Hinges: Door and frame manufacturer's standard or existing location scope per additional specifications and plans.
      b. Lever handles for latchsets, lockset and panic/exit device pull, lever trim:
         1) 38 inches above finish floor/surface.
         2) Verify manufacturer's template with door design.
      c. Panic devices push bar:
         1) Panic hardware shall be so mounted / centered between 36 inches and 44 inches above finished floor or ground.
         2) Verify manufacturer's template with door design to meet CBC 2022 exterior, pull side trim.
      d. Door Pulls and Push Bars (centerline): mounted / centered 42 inches above finished floor or ground.
      e. Door Push Plates (centerline): mounted / centered 42 inches above finished floor or ground.
      f. Where slider doors are in the fully open position, operating hardware shall be fully exposed and usable from both sides per CBC Section 11B-404.2.7.

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g. Closers:
   1) To meet opening force requirements
   2) See installation below.

2. Hardware for door handles, pulls, latches, locks, and other operating devices for use on means of egress doors shall comply with SFM Standard 12-10-2, Section 12-10-202 as contained in CCR Title 24, Part 12.

D. Installation:
1. Except for hinges, do not install hardware until painting and finishing work is completed.
2. Pre-drill pilot holes in wood for screws. Drill and tap for surface mounted hardware on metal.
3. Hinges: Set hinges snug and flat in mortises. Hand turn screws to flat seat – do not drive.
4. Locksets: Install locks with keyways in proper position. Install levers, roses, and escutcheons firmly affixed.
5. Closers:
   a. To open and latch smoke or fire rated doors correctly (positive latch at all times for rated doors when door is not in use), install closer units per factory templates to meet manufacturer requirements.
   b. To meet non-rated opening/exterior opening force requirements as well as close and latch non-smoke non-fire rated doors:
      1) Closers are to be installed as close to the hinge side of door as possible by a trained installer per this Section, Part 1 “Quality Assurance, Installer Qualifications”, installer an authorized representative of manufacturers, minimum of five years successful experience installing closers to meet 5-pound opening force for non-rated door complexity”.
      2) For non-smoke or non-fire rated doors, before installation of closers install one mockup door for each kind of closer application. Example: parallel, regular arm, stop arm and/or top-jamb arm application if specified. Confirm doors meet 5-pound opening force and still close door. This will ensure proper installation for doors to open at 5 pounds opening force before remaining non-rated opening closers are installed. The closer the closer is installed to the hinge, the better performance for 5 pound opening force, but still close and latch door.
   c. Mount door closers for maximum swing but at non-rated doors to meet 5-pound opening force. At all possible openings, mount door closers for maximum swing of door before setting stops.
   d. Mount door closers for maximum swing, but at non-rated doors to meet 5-pound opening force. Drawings may show doors open to only 90 degrees (Revit or CAD system set up), but unless noted or specified with limiter (stop arm devices below), all doors to open for maximum swing against adjacent 180 wall if nothing inhibits door from doing so. Include wide-throw hinges per specs and installation for 170-degree to 180-degree or maximum swing of door before installing stops.

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e. Floor Closers shall have concrete or metal installation case delivered and installed in floor slabs before concrete is poured. Additional floor closer device materials shall be delivered and installed with remainder of finish door hardware.

6. Floor Stops: See notes on closers and hinges above. After auto operator or closer devices are installed, and door is opened as far as possible without #1) occupant excessive force on auto operator or closer; and #2) door does not hit adjacent wall or other surfaces, stops shall be installed at substantial completion a maximum of 4 inches from adjacent walls and as far away from the hinge point as possible (preference is to have stops installed just below lever or pull locations).
7. Auto Door Bottom to not be adjusted until substantial completion. Door bottoms are to be raised to highest position while construction occurs so to not have rubber seal torn or damaged by debris under the door. At substantial completion, adjust door bottom to fully engage and touch the floor for proper sound dampening.
8. Thresholds:
   a. Set thresholds in waterproof full bed sealant (to prevent water penetration into building) and fasten anchors in pre-drilled countersunk holes 18 inch on center maximum spacing and within 3 inches of each end. Minimum three anchors per threshold.

E. Coordinate with Contact Documents including, but not limited to, Division 09 for paint and primer requirements.

F. Fire rated labels on doors and frames shall not be painted.

3.3 ADJUSTING

A. Adjust parts for smooth, uniform operation.

B. Lubricate moving parts with manufacturer recommended lubricant.

C. Replace units that cannot be adjusted and lubricated to operate freely and smoothly as intended for the application.

D. Adjust door closer devices:
   1. Adjust closer operating.
      a. Interior and Exterior Doors: not to exceed 5.0 pounds force.
      b. When fire doors are required, the maximum effort to operate the door may be increased to the minimum allowed by the appropriate administrative authority, not to exceed 15 pounds opening force.
   2. Adjust closer delay and operating speeds to comply with requirements of 2022 CBC Section 11B-404.2.8.1 and ADA – Americans with Disabilities Act - 2010 Standards for Accessible Design.
      a. Doors closers, when provided, shall have sweep period adjusted: minimum of 5 seconds for a door to close from the 90-degree position to the 12-degree position.

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b. Doors with spring hinges require a minimum of 1.5 seconds to close from the 70 degree to the closed position.

3.4 CLEANING

A. Clean as recommended by manufacturer. Do not use materials or methods which may damage finish or surrounding construction.

3.5 HARDWARE SCHEDULE

A. Manufacturers Legend

Code	Name
MC	McKinney Manufacturing
BE	BEST locks by Dorma Manufacturing
CA	Command Manufacturing
VO	Von Duprin Manufacturing
LC	LCN Closers
IV	H.B. Ives Manufacturing
PE	Pemko Manufacturing
TR	Trimco Manufacturing
AD	Adams Rite Manufacturing

B. Hardware Columns - Example (Legend):

Qty	Device Description Manu	Device # (include specification language)	Finish	
1	- - - - - - - - - - - -	- - - - - - - - - - - -	- -	- -

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D. The following hardware sets are intended to establish type and standard of quality when used together with the requirements of this Section (see above section and related sections including Division 01).

1. Examine Contract Documents and furnish proper hardware for door openings.
2. Refer to Door Schedule on the Drawings for Hardware Group/Set assignments for each opening.

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Hardware Group/Set #101

In addition to the devices specified in hardware group/set below, also coordinate devices in specification Sections 087113 "Automatic Door Operators" and Sections 081713 "Integrated Door Assemblies" with always locked lever (furnish and install doors, frames and related scope per complete Contract Documents):					
1	Ea.	Best Cylinder x Small Format Interchangeable Core	1E72 or 1E74 appropriate cam x blocking rings as required (rim or mortise type & quantity as required by locking device)	626	BE
1	Ea.	Permanent Small Format Interchangeable Core	1C7 x Patented Keyway per owner's requirement	626	BE
2	Ea.	Wall Stop		626	TR
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).					

Hardware Group/Set #101.1

Door #1S4A is now dual egress (no longer same swing pair, see 08 17 13 updates to hardware in that integrated door Section as well as updates in 08 71 13 for auto operators). In addition to the devices specified in hardware group/set below, also coordinate devices in specification Sections 087113 "Automatic Door Operators" and Sections 081713 "Integrated Door Assemblies" with always locked lever (furnish and install doors, frames and related scope per complete Contract Documents):					
2	**Ea.**	**Wall Stop**	**1270CV**	**626**	**TR**
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).					

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Hardware Groups/Sets #102

Note 1: In addition to the devices specified in hardware group/set below, also coordinate devices in specification Section 087113 "Automatic Door Operators". Furnish and install doors, frames and related scope per complete Contract Documents.					
2	Ea.	Hollow Metal Door Swing Clear Continuous Hinges with adjustable fasteners	#HG-326 x M91-0005-630 (Adjust-A-Screw, adjustable fasteners feature or accepted equal) x reinforcement as required by doors/frames x prep for EPT at active leaf	630	MA
1	Ea.	Electrified Power Transfer	4612-SC (swing clear application)	626	AD
1	Ea.	Inactive Leaf: Auto Flush Bolt (top latch only where possible)	At non-rated 20-minute rated wood doors or at all hollow metal doors provide either #3810 (metal doors) or #3815L (wood doors) as required per door material. For wood doors over 20-minutes in rating (no bottom bolt on smoke or 20-minute doors), provide top & bottom Flushbolts #3815L x #3815L and dust proof strike device #3911. For metal doors over 20 minutes in rating, provide fire bolt #3850 (no bottom bolt or dust proof strike).	626/ 630	TR
1	Ea.	Electric Latch Retraction, Lockset x Mortise for 3/4" required latch throw to meet code	LPM190EU x l6 lever trim RX (key on card reader-side of door)	626	CA
1	Ea.	Best Cylinder x Small Format Interchangeable Core	1E72 or 1E74 appropriate cam x blocking rings as required (rim or mortise type & quantity as required by locking device)	626	BE
1	Ea.	Permanent Small Format Interchangeable Core	1C7 x Patented Keyway per owner's requirement	626	BE
1	Ea.	Coordinator	#3094 series x filler plates x mounting brackets as required for coordinated hardware		TR
2	Ea.	Automatic Operator System	See Section 087113		
2	Ea.	Armor Plate	KA050 34" tall x 3" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
2	Ea.	Stop	1214	626	TR
1	Ea.	Seals	S88D seals (head and jambs) by Pemko or approved (at rated doors provide additional full height overlapping astragal and S77D seal)		

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2	Ea.	Astragal and Edge Guards	EG-308 x EG-T-308
1	Ea.	Power Supply	Furnish and install #1) single gang power drop located above or near door (not in corridor or public view, but above celling line where possible); #2) provide power supply #PS220 BB (battery backup for additional auto operator opening cycles when there is power loss) by Command Access manufacturing; #3) run conduit from hinge through frame and complete wiring as required to meet manufacturer warranties
1	Ea.	Door Position Switch (door contacts)	See note below as this Section does not direct card reader locations or non-Div. 08 security devices
1	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope [including but not limited to #1) wire / connectivity from ceiling through frame to electrified hardware, #2) Door Position Switch (also known as door contacts); #3) REX security switch (see free egress note in above specifications)]	Coordinate with security or electrical Divisions 25-28 and applicable drawings: - If these security devices (wire/connectivity/card readers) are added or deleted from project 087100 doors do not require updates as hardware does not direct card reader or non-087100 security devices. - The electrified hardware specified above can be utilized for #1) non-card reader, remote access control applications (unlocked / locked remotely for open during business hours / locked after-hours) and #2) or could be utilized for local card readers at openings as directed by security drawings. - All project doors have free egress at all times with no special knowledge to exit. The free egress side of door “REX” feature is a security feature that announces/tells the security system if occupant is leaving the building interior area, egress side of door and will not in any way affect free egress. REX security switch/contact part that requires coordination with security is specified in above locking hardware. - If door position switch is require by security drawings as they are at all doors assigned card readers, template door and frame to receive security specified door position switch diameter/size (per this contractual wording, this is means and methods and not designer work, 087100 to bid hours to verify security drawings before hardware submittals and submit separate line item for each project door that requires door position switches listing size to be cut in door and/or frame).
Note 2: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents including, but not limited to, additional hardware devices			

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requirements in the above specification language, architectural plans, and full specification documents.

Hardware Group/Set #103

In addition to the devices specified in hardware group/set below, also coordinate devices in specification Sections 087113 “Automatic Door Operators” and Sections 081713 “Integrated Door Assemblies” (furnish and install doors, frames and related scope per complete Contract Documents):					
2	Ea.	Wall Stop	1270CV	626	TR
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).					

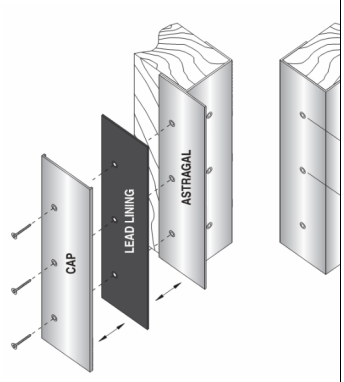
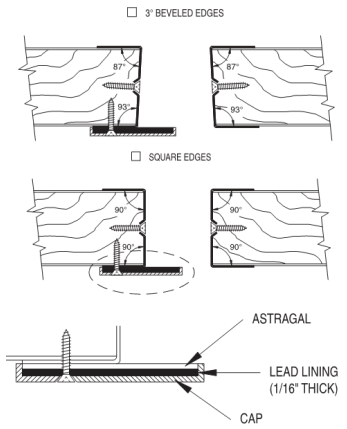
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Hardware Groups/Sets #104

Note 1: In addition to the devices specified in hardware group/set below, also coordinate devices in specification Section 087113 “Automatic Door Operators”. Furnish and install doors, frames and related scope per complete Contract Documents.					
1	Ea.	Lead-Lined Door Application Continuous Hinge Electrified Wire Transfer	SL11-LL device (120 inch or length as required for door height) x #ATW accessible through wire transfer	AL	SE
1	Ea.	Lead-Lined Door Continuous Hinge	SL11-LL device (120 inch or length as required for door height)	AL	SE
1	Ea.	Auto Flush Bolt (top latch only where possible)	At non-rated 20-minute rated wood doors or at all hollow metal doors provide either #3810 (metal doors) or #3815L (wood doors) as required per door material. For wood doors over 20-minutes in rating (no bottom bolt on smoke or 20-minute doors), provide top & bottom Flushbolts #3815L x #3815L and dust proof strike device #3911. For metal doors over 20 minutes in rating, provide fire bolt #3850 (no bottom bolt or dust proof strike).	626/ 630	TR
1	Ea.	Lead-Lined Door Application Electric Latch Retraction, Passage Latchset x Mortise for 3/4” required latch throw to meet code	LPM1910EU x l6 lever trim x Lead Line application/parts per specifications	626	CA
1	Ea.	Coordinator	#3094 series x filler plates x mounting brackets as required for coordinated hardware		TR
2	Ea.	Automatic Operator System	See Section 087113		
2	Ea.	Armor Plate	KA050 34” tall x 3" LDW (less door width) x B4E (beveled edges) x approved adhesive for lead-lined per 08 71 00.Part 2 (no raised fasteners)	630	TR
2	Ea.	Stop	1270CV or 1214	626	TR
1	Ea.	Seals	S88D seals (head and jambs) x full height S77D seal for astragal by Pemko or approved		

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1	Ea.	Lead-Line Overlapping Astragal 	FMEA lead-line overlapping astragal x UL or template cut outs for strike and auto flush bolt (provide bevel as required by door manufacturer) x 630 by Anemostat/NGP manufacturing or approved equal 	
1	Ea.	Power Supply	Furnish and install #1) single gang power drop located above or near door (not in corridor or public view, but above celling line where possible); #2) provide power supply #PS220 BB (battery backup for additional auto operator opening cycles when there is power loss) by Command Access manufacturing; #3) run conduit from hinge through frame and complete wiring as required to meet manufacturer warranties	
1	Ea.	Coordination task for electrical design and additional non-Division 08 Section scope including but not limited to wire / connectivity from ceiling through frame to electrified hardware		Coordinate with electrical Divisions 25-28 and applicable drawings
Note 2: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans, and full specification documents.				

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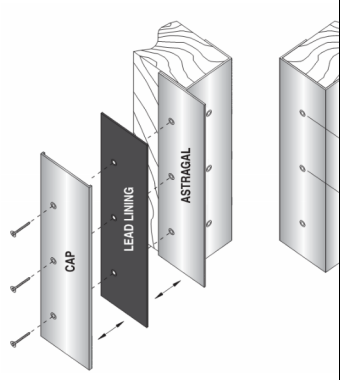
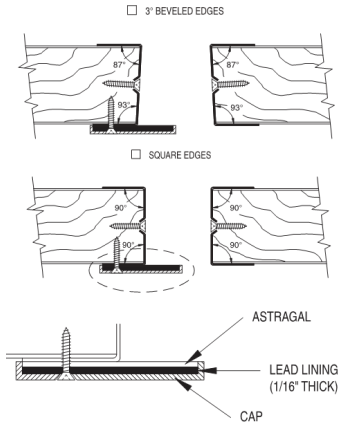
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Hardware Groups/Sets #105

Note 1: In addition to the devices specified in hardware group/set below, also coordinate devices in specification Section 087113 “Automatic Door Operators”. Furnish and install doors, frames and related scope per complete Contract Documents.					
1	Ea.	Lead-Lined Door Application Continuous Hinge Electrified Wire Transfer	SL11-LL device (120 inch or length as required for door height) x #ATW accessible through wire transfer	AL	SE
1	Ea.	Lead-Lined Door Continuous Hinge	SL11-LL device (120 inch or length as required for door height)	AL	SE
1	Ea.	Auto Flush Bolt (top latch only where possible)	At non-rated 20-minute rated wood doors or at all hollow metal doors provide either #3810 (metal doors) or #3815L (wood doors) as required per door material. For wood doors over 20-minutes in rating (no bottom bolt on smoke or 20-minute doors), provide top & bottom Flushbolts #3815L x #3815L and dust proof strike device #3911. For metal doors over 20 minutes in rating, provide fire bolt #3850 (no bottom bolt or dust proof strike).	626/ 630	TR
1	Ea.	Lead-Lined Door Application Electric Latch Retraction, Lockset x Mortise for 3/4” required latch throw to meet code	LPM190EU x REX x l6 lever trim x Lead Line application/parts per specifications	626	CA
1	Ea.	Best Cylinder x Small Format Interchangeable Core	1E72 or 1E74 appropriate cam x blocking rings as required (rim or mortise type & quantity as required by locking device)	626	BE
1	Ea.	Permanent Small Format Interchangeable Core	1C7 x Patented Keyway per owner’s requirement	626	BE
1	Ea.	Coordinator	#3094 series x filler plates x mounting brackets as required for coordinated hardware		TR
2	Ea.	Automatic Operator System	See Section 087113		
2	Ea.	Armor Plate	KA050 34” tall x 3" LDW (less door width) x B4E (beveled edges) x approved adhesive for lead-lined per 08 71 00.Part 2 (no raised fasteners)	630	TR
2	Ea.	Stop	1270CV or 1214	626	TR
1	Ea.	Seals	S88D seals (head and jambs) x full height S77D seal for astragal by Pemko or approved		

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1	Ea.	Lead-Line Overlapping Astragal 	FMEA lead-line overlapping astragal x UL or template cut outs for strike and auto flush bolt (provide bevel as required by door manufacturer) x 630 by Anemostat/NGP manufacturing or approved equal 
1	Ea.	Power Supply	Furnish and install #1) single gang power drop located above or near door (not in corridor or public view, but above celling line where possible); #2) provide power supply #PS220 BB (battery backup for additional auto operator opening cycles when there is power loss) by Command Access manufacturing; #3) run conduit from hinge through frame and complete wiring as required to meet manufacturer warranties
2	Ea.	Door Position Switch (door contacts)	See note below as this Section does not direct card reader locations or non-Div. 08 security devices
1	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope [including but not limited to #1) wire / connectivity from ceiling through frame to electrified hardware, #2) Door Position Switch (also known as door contacts); #3) REX security switch (see free egress note in above	Coordinate with security or electrical Divisions 25-28 and applicable drawings: - If these security devices (wire/connectivity/card readers) are added or deleted from project 087100 doors do not require updates as hardware does not direct card reader or non-087100 security devices. - The electrified hardware specified above can be utilized for #1) non-card reader, remote access control applications (unlocked / locked remotely for open during business hours / locked after-hours) and #2) or could be utilized for local card readers at openings as directed by security drawings. - All project doors have free egress at all times with no special knowledge to exit. The free egress side of door "REX" feature is a security feature that announces/tells the security system if occupant is leaving the building interior area, egress side of door and will not in any way affect free egress. REX security switch/contact part that requires coordination with security is specified in above locking hardware. If door position switch is require by security drawings as they are at all doors assigned card readers, template door and frame to receive security specified door position switch diameter/size (per this contractual wording, this is means and

		specifications)]	methods and not designer work, 087100 to bid hours to verify security drawings before hardware submittals and submit separate line item for each project door that requires door position switches listing size to be cut in door and/or frame).
Note 2: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans, and full specification documents.			

Hardware Group/Set #106

See specification Section 081713 “Integrated Door Assemblies” (furnish and install doors, frames and related scope per complete Contract Documents). Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).

Hardware Group/Set #107

In addition to the devices specified in hardware group/set below, also coordinate devices in specification Section 081713 “Integrated Door Assemblies” with always locked lever (furnish and install doors, frames and related scope per complete Contract Documents):					
1	Ea.	Best Cylinder x Small Format Interchangeable Core	1E72 or 1E74 appropriate cam x blocking rings as required (rim or mortise type & quantity as required by locking device)	626	BE
1	Ea.	Permanent Small Format Interchangeable Core	1C7 x Patented Keyway per owner’s requirement	626	BE
1	Ea.	Wall Stop	1270CV	626	TR
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).					

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Hardware Groups/Sets #108

__	Ea.	Hinge	T4A3786 (size & quantity per 087100)	652	MC
1	Ea.	Electrified Hinge Transfer	T4A3786 x 8-Wire (size per 087100)	652	MC
1	Ea.	Electrified Lockset	45HW-7DEU RX x 15H x S1	630	BE
1	Ea.	Best Cylinder x Small Format Interchangeable Core	1E72 or 1E74 appropriate cam x blocking rings as required (rim or mortise type & quantity as required by locking device)	626	BE
1	Ea.	Permanent Small Format Interchangeable Core	1C7 x Patented Keyway per owner's requirement	626	BE
1	Ea.	Surface Closer	4040XP (whether or not marked throughout all headings, per specifications verify closers will be installed in non-corridor/non-public view sides and 180-degrees at parallel arms)	689	LC
1	Ea.	Kick Plate	KO050 12" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Stop	1270CV	626	TR
1	Ea.	Seals	S88D seals (head and jambs) by Pemko or approved		
1	Ea.	Door Position Switch (door contacts)	See note below as this Section does not direct card reader locations or non-Div. 08 security devices		
1	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope [including but not limited to #1) wire / connectivity from ceiling through frame to electrified hardware, #2) Door Position Switch (also known as door contacts); #3) REX security switch (see free egress note in	Coordinate with security or electrical Divisions 25-28 and applicable drawings: - If these security devices (wire/connectivity/card readers) are added or deleted from project 087100 doors do not require updates as hardware does not direct card reader or non-087100 security devices. - The electrified hardware specified above can be utilized for #1) non-card reader, remote access control applications (unlocked / locked remotely for open during business hours / locked after-hours) and #2) or could be utilized for local card readers at openings as directed by security drawings. - All project doors have free egress at all times with no special knowledge to exit. The free egress side of door "REX" feature is a security feature that announces/tells the security system if occupant is leaving the building interior area, egress side of door and will not in any way affect free egress. REX security switch/contact part that requires coordination with security is specified in above locking hardware. - If door position switch is require by security drawings as they are at all doors assigned card readers, template door and frame to receive security specified door position switch		

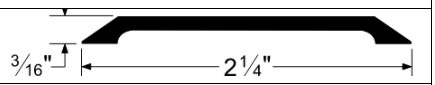
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		above specifications)]	diameter/size (per this contractual wording, this is means and methods and not designer work, 087100 to bid hours to verify security drawings before hardware submittals and submit separate line item for each project door that requires door position switches listing size to be cut in door and/or frame).
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans, and full specification documents.			

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Hardware Groups/Sets #109

_	Ea.	Hinge	TA2714 (size & quantity per 087100)	652	MC
1	Ea.	Electrified Hinge	TA2714 x 8-Wire (size per 087100)	652	MC
1	Ea.	Electrified Lockset	45HW-7DEU RX x 15H x S1	630	BE
1	Ea.	Best Cylinder (SFIC)	1E72 or 1E74 appropriate cam x blocking rings as required (rim or mortise type & quantity as required by locking device)	626	BE
1	Ea.	Permanent Core	1C7 x Patented Keyway per owner's requirement	626	BE
1	Ea.	Closer	4040XP ~~REG~~ **parallel** arm (installed ~~pull~~**push**-side of door **for 180-degree swing**)	689	LC
1	Ea.	Kick Plate	KO050 12" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Stop	1270CV	626	TR
1	Ea.	Seals	S88D seals (head and jambs) by Pemko or approved		
1	Ea.	Auto Door Bottom	411APKL or 420APKL (as required per door material or wood or hollow metal)		
~~1~~	~~Ea.~~	~~Threshold – final to be selected~~	~~173D (flat) by Pemko x full bed of mastic~~ 		
1	Ea.	Door Position Switch	See note below as this Section does not direct card reader locations or non-Div. 08 security devices		
1	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope [including but not limited to #1) wire / connectivity from ceiling through frame to electrified hardware, #2) Door Position Switch (also known as door contacts); #3) REX security switch (see free egress note in above specifications)]	Coordinate with security or electrical Divisions 25-28 and applicable drawings: - If these security devices (wire/connectivity/card readers) are added or deleted from project 087100 doors do not require updates as hardware does not direct card reader or non-087100 security devices. - The electrified hardware specified above can be utilized for #1) non-card reader, remote access control applications (unlocked / locked remotely for open during business hours / locked after-hours) and #2) or could be utilized for local card readers at openings as directed by security drawings. - All project doors have free egress at all times with no special knowledge to exit. The free egress side of door "REX" feature is a security feature that announces/tells the security system if occupant is leaving the building interior area, egress side of door and will not in any way affect free egress. REX security switch/contact part that requires coordination with security is specified in above locking hardware. - If door position switch is require by security drawings as they are at all doors assigned card readers, template door and frame to receive security specified door position		

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			switch diameter/size (per this contractual wording, this is means and methods and not designer work, 087100 to bid hours to verify security drawings before hardware submittals and submit separate line item for each project door that requires door position switches listing size to be cut in door and/or frame).
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans, and full specification documents.			

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Hardware Groups/Sets #110

_	Ea.	Hinge	TA2714 (size & quantity per 087100)	652	MC
1	Ea.	Electrified Hinge	TA2714 x 8-Wire (size per 087100)	652	MC
1	Ea.	Electrified Rim Exit Device x Keyed Lever	RX AX 99L-F E996L-R/V x 06 Lever	626	VO
1	Ea.	Best Cylinder (SFIC)	1E72 or 1E74 appropriate cam x blocking rings as required (rim or mortise type & quantity as required by locking device)	626	BE
1	Ea.	Permanent Core	1C7 x Patented Keyway per owner's requirement	626	BE
1	Ea.	Closer	4040XP (installed 180 x push-side of door)	689	LC
1	Ea.	Kick Plate	KO050 12" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Stop	1270CV	626	TR
1	Ea.	Seals	S88D seals (head and jambs) by Pemko or approved		
1	Ea.	Auto Door Bottom	411APKL or 420APKL (as required per door material or wood or hollow metal)		
1	Ea.	Threshold (sound dampening)	173D (flat) by Pemko x full bed of mastic 		
1	Ea.	Door Position Switch (door contacts)	See note below as this Section does not direct card reader locations or non-Div. 08 security devices		
1	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope [including but not limited to #1) wire / connectivity from ceiling through frame to electrified hardware, #2) Door Position Switch (also known as door contacts); #3) REX security switch (see free egress note in above	Coordinate with security or electrical Divisions 25-28 and applicable drawings: - If these security devices (wire/connectivity/card readers) are added or deleted from project 087100 doors do not require updates as hardware does not direct card reader or non-087100 security devices. - The electrified hardware specified above can be utilized for #1) non-card reader, remote access control applications (unlocked / locked remotely for open during business hours / locked after-hours) and #2) or could be utilized for local card readers at openings as directed by security drawings. - All project doors have free egress at all times with no special knowledge to exit. The free egress side of door "REX" feature is a security feature that announces/tells the security system if occupant is leaving the building interior area, egress side of door and will not in any way affect free egress. REX security switch/contact part that requires coordination with security is specified in above locking hardware.		

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		specifications)]	- If door position switch is require by security drawings as they are at all doors assigned card readers, template door and frame to receive security specified door position switch diameter/size (per this contractual wording, this is means and methods and not designer work, 087100 to bid hours to verify security drawings before hardware submittals and submit separate line item for each project door that requires door position switches listing size to be cut in door and/or frame).
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans, and full specification documents.			

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Hardware Groups/Sets #111

_	Ea.	Hinge	TA2714 (size & quantity per 087100)	652	MC
1	Ea.	Electrified Hinge	TA2714 x 8-Wire (size per 087100)	652	MC
1	Ea.	Electrified Lockset	45HW-7DEU RX x 15H x S1	630	BE
1	Ea.	Best Cylinder (SFIC)	1E72 or 1E74 appropriate cam x blocking rings as required (rim or mortise type & quantity as required by locking device)	626	BE
1	Ea.	Permanent Core	1C7 x Patented Keyway per owner's requirement	626	BE
1	Ea.	Closer	4040XP (installed push-side of door)	689	LC
1	Ea.	Kick Plate	KO050 12" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2	630	TR
1	Ea.	Floor Stop	1214	626	TR
1	Ea.	Seals	S88D seals (head and jambs) by Pemko or approved		
1	Ea.	Door Position Switch	See note below as this Section does not direct card reader locations or non-Div. 08 security devices		
1	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope [including but not limited to #1) wire / connectivity from ceiling through frame to electrified hardware, #2) Door Position Switch (also known as door contacts); #3) REX security switch (see free egress note in above specifications)]	Coordinate with security or electrical Divisions 25-28 and applicable drawings: - If these security devices (wire/connectivity/card readers) are added or deleted from project 087100 doors do not require updates as hardware does not direct card reader or non-087100 security devices. - The electrified hardware specified above can be utilized for #1) non-card reader, remote access control applications (unlocked / locked remotely for open during business hours / locked after-hours) and #2) or could be utilized for local card readers at openings as directed by security drawings. - All project doors have free egress at all times with no special knowledge to exit. The free egress side of door "REX" feature is a security feature that announces/tells the security system if occupant is leaving the building interior area, egress side of door and will not in any way affect free egress. REX security switch/contact part that requires coordination with security is specified in above locking hardware. - If door position switch is require by security drawings as they are at all doors assigned card readers, template door and frame to receive security specified door position switch diameter/size (per this contractual wording, this is means and methods and not designer work, 087100 to bid hours to verify security drawings before hardware submittals and submit separate line item for each project door that requires door position switches listing size to be cut in door and/or frame).		
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents including, but not limited to, additional hardware devices					

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requirements in the above specification language, architectural plans, and full specification documents.

Hardware Group/Set #112

In addition to the devices specified in hardware group/set below, also coordinate devices in specification Sections 087113 “Automatic Door Operators” and Sections 081713 “Integrated Door Assemblies” (furnish and install doors, frames and related scope per complete Contract Documents):					
1	Ea.	Wall Stop – final to be selected	1270CV	626	TR
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).					

Hardware Group/Set #113

__	Ea.	Hinge	T4A3786 (size and quantity per 087100)	652	MC
1	Ea.	Privacy x Indicator (exterior side lever left unlocked when room is vacant)	45H-7AB x 15H x VIN x S1 x (emergency cylinder/key override x VIN indicator x ADA Thumbturn) 	630	BE
1	Ea.	Best Cylinder (SFIC)	1E72 or 1E74 appropriate cam x blocking rings as required (rim or mortise type & quantity as required by locking device)	626	BE
1	Ea.	Permanent Core	1C7 x Patented Keyway per owner’s requirement	626	BE
1	Ea.	Surface Closer x Stop Arm	4040XP x CUSH	689	LC
1	Ea.	Kick Plate	KO050 12" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Seals	S88D seals (head and jambs) by Pemko or approved		
~~1~~	~~Ea.~~	~~Auto Door Bottom~~	~~411APKL or 420APKL (as required per door material or wood or hollow metal) by Pemko or approved manufacturer~~		
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).					

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Hardware Group/Set #114

__	Ea.	Hinge	T4A3786 (size and quantity per 087100)	652	MC
1	Ea.	Privacy x Indicator (exterior side lever left unlocked when room is vacant)	45H-7AB x 15H x VIN x S1 x (emergency cylinder/key override x VIN indicator x ADA Thumbturn) 	630	BE
1	Ea.	Best Cylinder (SFIC)	1E72 or 1E74 appropriate cam x blocking rings as required (rim or mortise type & quantity as required by locking device)	626	BE
1	Ea.	Permanent Core	1C7 x Patented Keyway per owner's requirement	626	BE
1	Ea.	Closer	4040XP (installed 180 x push-side of door)	689	LC
1	Ea.	Kick Plate	KO050 12" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Stop	1270CV	626	TR
1	Ea.	Seals	S88D seals (head and jambs) by Pemko or approved		
~~1~~	~~Ea.~~	~~Auto Door Bottom~~	~~411APKL or 420APKL (as required per door material or wood or hollow metal) by Pemko or approved manufacturer~~		

Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).

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Hardware Group/Set #115

__	Ea.	Hinge	T4A3786 (size and quantity per 087100)	652	MC
1	Ea.	Privacy x Indicator (exterior side lever left unlocked when room is vacant)	45H-7AB x 15H x VIN x S1 x (emergency cylinder/key override x VIN indicator x ADA Thumbturn) 	630	BE
1	Ea.	Best Cylinder (SFIC)	1E72 or 1E74 appropriate cam x blocking rings as required (rim or mortise type & quantity as required by locking device)	626	BE
1	Ea.	Permanent Core	1C7 x Patented Keyway per owner's requirement	626	BE
1	Ea.	Closer	4040XP (installed pull-side of door)	689	LC
1	Ea.	Kick Plate	KO050 12" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Mop Plate	KO050 6" tall x 1" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Stop	1270CV	626	TR
1	Ea.	Seals	S88D seals (head and jambs) by Pemko or approved		
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).					

Hardware Group/Set #116

1	Ea.	Continuous Hinges	SL11-LL (lead-lined application)	AL	SE
1	Ea.	Passage Latchset (lead-lined)	45H-0N x 15H x S1 x Lead Line application/parts per specifications	630	BE
1	Ea.	Closer	4040XP (push-side of door)	689	LC
1	Ea.	Armor Plate	KA050 34" tall x 2" LDW (less door width) x B4E (beveled edges) x approved adhesive for lead-lined per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	~~Wall~~ **Floor** Stop	~~1270CV~~ **1214**	626	TR
1	Ea.	Seals	S88D seals (head and jambs) by Pemko or approved		
Note: Furnish and install all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices required in specifications language above, architectural plans and full specification documents).					

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Hardware Group/Set #116.1

__	Ea.	Swing Clear Hinge	T4A3795 5 inch or beveled edge T4A4795 5 inch as required per opening (quantity per 087100)	652	MC
1	Ea.	Storeroom Lockset	45H-7D x 15H x S1	630	BE
1	Ea.	Best Cylinder (SFIC)	1E72 or 1E74 appropriate cam x blocking rings as required (rim or mortise type & quantity as required by locking device)	626	BE
1	Ea.	Permanent Core	1C7 x Patented Keyway per owner's requirement	626	BE
1	Ea.	Closer	4040XP (installed 180 x push-side of door)	689	LC
1	Ea.	Armor Plate	KA050 34" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Stop	1270CV	626	TR
1	Ea.	Seals	S88D seals (head and jambs) by Pemko or approved		
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).					

Hardware Group/Set #117

__	Ea.	Hinge	T4A3786 (size & quantity per 087100)	652	MC
1	Ea.	Passage Latchset	45H-0N x 15H x S1	630	BE
1	Ea.	Closer	4040XP x REG (installed pull-side of door)	689	LC
1	Ea.	Kick Plate	KO050 12" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Wall Stop	1270CV	626	TR
1	Ea.	Seals	S88D seals (head and jambs) by Pemko or approved		
Note: Furnish and install all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices required in specifications language above, architectural plans and full specification documents).					

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Hardware Group/Set #118

__	Ea.	Hinge	T4A3786 (size and quantity per 087100)	652	MC
1	Ea.	**Passage Latchset**~~Push Plate~~	**45H-0N x 15H x S1** ~~1001-3-20" x custom 20" high plate (total size 4" wide x 20" tall) x BHMA 710CU (Healthy Hardware Antimicrobial)~~	**630** ~~710 CU~~	**BE** ~~TR~~
~~1~~	~~Ea.~~	~~Pull plate~~	~~1017-3 (4" x 16") x BHMA 710CU (Healthy Hardware Antimicrobial)~~	~~710 CU~~	~~TR~~
1	Ea.	Surface Closer	4040XP REG arm (installed pull-side)	689	LC
1	Ea.	Kick-Plate	KO050 12" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Wall Stop	1270CV	626	TR
1	Ea.	Seals	S88D seals (head and jambs) by Pemko or approved		
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).					

Hardware Group/Set #119

__	Ea.	Swing Clear Hinge	T4A3795 5 inch or beveled edge T4A4795 5 inch as required per opening (quantity per 087100)	652	MC
1	Ea.	Classroom Lockset	45H-7R x 15H x S1	630	BE
1	Ea.	Best Cylinder (SFIC)	1E72 or 1E74 appropriate cam x blocking rings as required (rim or mortise type & quantity as required by locking device)	626	BE
1	Ea.	Permanent Core	1C7 x Patented Keyway per owner's requirement	626	BE
1	Ea.	Surface Closer	4040XP REG arm (installed pull-side) x DA	689	LC
1	Ea.	Armor Plate	KA050 34" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Stop	1270CV or 1214	626	TR
1	Ea.	Seals	S88D seals (head and jambs) by Pemko or approved		
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).					

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Hardware Group/Set #120

__	Ea.	Swing Clear Hinge	T4A3795 5 inch or beveled edge T4A4795 5 inch as required per opening (quantity per 087100)	652	MC
1	Ea.	Storeroom Lockset	45H-7D x 15H x S1	630	BE
1	Ea.	Best Cylinder (SFIC)	1E72 or 1E74 appropriate cam x blocking rings as required (rim or mortise type & quantity as required by locking device)	626	BE
1	Ea.	Permanent Core	1C7 x Patented Keyway per owner's requirement	626	BE
1	Ea.	Surface Closer	4040XP REG arm (installed pull-side) x DA	689	LC
1	Ea.	Armor Plate	KA050 34" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Stop	1270CV	626	TR
1	Ea.	Seals	S88D seals (head and jambs) by Pemko or approved		
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).					

Hardware Group/Set #121

__	Ea.	Hinge	T4A3786 (size & quantity per 087100)	652	MC
1	Ea.	Classroom Lockset	45H-7R x 15H x S1	630	BE
1	Ea.	Best Cylinder (SFIC)	1E72 or 1E74 appropriate cam x blocking rings as required (rim or mortise type & quantity as required by locking device)	626	BE
1	Ea.	Permanent Core	1C7 x Patented Keyway per owner's requirement	626	BE
1	Ea.	Closer	4040XP (installed 180 x push-side of door)	689	LC
1	Ea.	Armor Plate	KA050 34" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Stop	1270CV ~~– final to be selected~~	626	TR
1	Ea.	Seals	S88D seals (head and jambs) by Pemko or approved		
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).					

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Hardware Group/Set #122

__	Ea.	Hinge	TA2714 (size & quantity per 087100)	652	MC
1	Ea.	Storeroom Lockset	45H-7D x 15H x S1	630	BE
1	Ea.	Best Cylinder (SFIC)	1E72 or 1E74 appropriate cam x blocking rings as required (rim or mortise type & quantity as required by locking device)	626	BE
1	Ea.	Permanent Core	1C7 x Patented Keyway per owner's requirement	626	BE
1	Ea.	Closer	4040XP (installed 180 x push-side of door)	689	LC
1	Ea.	Kick Plate	KO050 12" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Stop	1270CV	626	TR
1	Ea.	Seals	S88D seals (head and jambs) by Pemko or approved		
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).					

Hardware Group/Set #123 – ICU Doors

Note 1: All hardware supplied by door or opening manufacturers (no 087100 scope).

Note 2: Furnish all devices and components for openings assigned this hardware groups/set in accordance with Contract Documents (requirements in project manual and architectural plans).

Hardware Group/Set #124

See specification Section 081713 "Integrated Door Assemblies" (furnish and install doors, frames and related scope per complete Contract Documents). Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).

Blank space after a Group/Set is intentional to avoid, if possible, splitting a Hardware Group/Set onto two pages.

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Hardware Group/Set #125

__	Ea.	Hinge	T4A3786 (size & quantity per 087100)	652	MC
1	Ea.	Passage Latchset	45H-0N x 15H x S1	630	BE
1	Ea.	Closer	4040XP parallel arm (installed push-side of door)	689	LC
1	Ea.	Kick Plate	KO050 12" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Wall Mag Holder Devices	2400L series x armature extension x 689 finish by ABH manufacturing or equal by Syntegra	689	AB
1	Ea.	Wall Mag Armature Extensions	S20020 (or length as required 90 degree swing parallel to adjacent wall) x 689 finish by ABH manufacturing or equal by Syntegra	689	AB
1	Ea.	Seals	S88D seals (head and jambs) by Pemko or approved		

Note 1: Furnish and install all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices required in specifications language above, architectural plans and full specification documents).

Note 2: Description of Operation: When door is placed in opened position, Magnetic Holder will automatically engage hold open mechanism (magnet). Door releases hold open and fully closes door by manual pulling of door or by the following, self-closing functions: 1) Close on fire alarm activation (Verify voltage and coordinate integration with fire alarm system; or 2) Close due to loss of power (coordinate integration with local power system). Coordinate with divisions 25-28 and applicable FLS drawings.

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Hardware Group/Set #126

__	Ea.	Hinge	T4A3786 (size & quantity per 087100)	652	MC
1	Ea.	Office Lockset	45H-7AD x 15H	630	BE
1	Ea.	Best Cylinder (SFIC)	1E72 or 1E74 appropriate cam x blocking rings as required (rim or mortise type & quantity as required by locking device)	626	BE
1	Ea.	Permanent Core	1C7 x Patented Keyway per owner's requirement	626	BE
1	Ea.	Closer	4040XP (installed 180 x push-side of door)	689	LC
1	Ea.	Kick Plate	KO050 12" tall x 2" LDW (less door width) x B4E (beveled edges) x counter sunk or approved adhesive per 08 71 00.Part 2 (no raised fasteners)	630	TR
1	Ea.	Stop	1270CV	626	TR
1	Ea.	Seals	S88D seals (head and jambs) by Pemko or approved		
Note: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents (including but not limited to additional hardware devices requirements in the above specification language, architectural plans and full specification documents).					

END OF SECTION

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SECTION 08 71 13 - AUTOMATIC DOOR OPERATORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. BHMA electrified, swinging door automatic operator devices.

B. Accessories including but not limited to actuating controls and safety sensors at designated doors.

1.2 PRODUCTS SUPPLIED BUT NOT INSTALLED UNDER THIS SECTION

A. Hardware templates for doors and frames.

1.3 RELATED SECTIONS

A. Summary of Work: Division 01, applicable Sections, including but not limited to:
   1. Section 01 74 19 "Construction and Demolition Waste Management and Disposal."
   2. Section 01 81 13 "Sustainable Design Requirements" for LEED v4 requirements.

B. Swinging Gates: Division 05 and/or Division 32 Metal Fabrications, applicable Sections including, but not limited to, ornamental, wood, and/or chain link gates.

C. Masonry: Division 04, applicable Sections.

D. Carpentry: Division 06, applicable Sections (Section 06 10 00 Rough Carpentry).

E. Perimeter Sealants and Insulation: Division 07, applicable Sections.

F. Division 08, applicable Sections including, but not limited to, Wood Doors; Hollow Metal Doors and/or Frames; Storefront; Aluminum Doors and/or Aluminum Frames; Sliding Glass or Framed Doors; All-Glass Doors.

G. Section 08 17 13 – Integrated Door Assemblies.

H. Section 08 71 00 – Door Hardware.

I. Divisions 26 through 28: Electrical rough in, wiring and connectors for electrified hardware including, but not limited to:

   1. Wire and connectivity from ceiling through frame to electrified hardware devices including non-Section 08 71 13 task of providing wiring inside of doors.

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2. FLS (fire/life safety) connectivity scope: In event of fire/smoke/loss of building power events, electrified strikes and auto operators to become non-electrified (drop power for doors can close, positive latch and to be only manually operated). Electrified fail-secure levers do not require to be coordinated with FLS system.

1.4 PRODUCTS SUPPLIED BUT NOT INSTALLED UNDER THIS SECTION

A. Hardware templates for doors and frames.

1.5 REFERENCES

A. The publications listed below form a part of this Section to the extent referenced. The publications are referred to in the text by the basic designation only.
   1. Refer to Architect's Division 01 for definitions, acronyms, and abbreviations.
   2. Unless otherwise noted; standards, manuals, and codes refer to the latest edition as of the issue date of this Project Manual.

B. Conform to the following Referenced Standards and Requirements:
   1. CBC – 2022 California Building Code, including CBC Section 11B-404.3.
   2. ADA – Americans with Disabilities Act - 2010 Standards for Accessible Design.
   3. AAADM – American Association of Automatic Door Manufacturers.
   4. ANSI/BHMA 156.19 American National Standard for power high and low energy operated doors.
   5. ANSI A156 Series – Builders Hardware Manufacturers Association (BHMA) Standards.

1.6 COORDINATION

A. Coordinate work of this Section with Sections involving manufacturer of internal reinforcement for doors, frames, and hardware.
   1. Coordinate work in this Section with work in related Sections.
   2. This Section's hardware sets/groups as specified in Part 3 are intended to establish type and design standard when used together with the requirements of specifications, drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections. Where hardware sets/groups have different information than the specifications refer to the specifications and drawings for clarification and bid combined hardware sets/groups and Contract Documents/specifications (provide combined materials/devices at time of submittals).

B. Provide hardware templates to door and frame manufacturer. Provide 2 templates to those manufacturers who are not currently registered template book holders. Contractor shall be responsible for verifying that the door hardware accepted for installation is compatible for use with the doors and door frames.

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C. Coordinate keying requirements as specified in Section 08 71 00 “Door Hardware”.

D. Convene coordination meeting between all opening vendors and installers at least two weeks prior to purchasing doors, frames, door hardware and electrical devices required for complete systems.
   1. Required attendance includes but is not limited to the following: Contractor; hardware supplier and/or installer; door supplier and/or installer; frame supplier and/or installer; auto operator vendor and/or installer; security card reader vendor and/or installer; and electrical.
   2. Contractor shall be responsible for verifying that the door hardware accepted for installation is compatible for use with the doors and door-frames.
   3. For card reader interface with applicable door devices, security vendor and/or installer (coordinate accordingly) to have a written agenda and plan on how scope related to electrified devices will be installed to have a complete wired and operational card access system. The card reader interface scope includes but is not limited to card reader inputs and output coordination on the electric locking device power supply, electric locking devices and connectivity as well as confirmation of a complete, wired and operational card access system. Provide all required relays and devices as part of the overall system in accordance system requirements at no additional cost to Owner.
   4. For auto operator interface with applicable door devices, auto operator vendor and/or installer (coordinate accordingly) to have a written agenda and plan on how scope related to electrified devices will be installed to have a complete wired and operational auto operator system. The auto operator interface scope includes but is not limited to connectivity and inputs for push-plates, BEA BR3 (or approved equal required auto operator relays), electric locking devices, as well as confirmation of the complete, wired and operational auto operator system. Provide all required relays and devices as part of the overall system in accordance system requirements at no additional cost to Owner.
   5. Vendor and/or installer (coordinate accordingly) not responsible for electrical-power (see electrical drawings) or FLS (fire/life safety) connectivity to above frame or back-of-house power supply (back-of-house meaning remote low voltage power). FLS connectivity only required for fire or smoke rated opening in particular functions to meet code as scheduled.

E. Examine Contract Documents and furnish proper hardware for door openings. Example includes, but is not limited to system integration:
   1. Provide electrical interface control capability for card reader or keypad operation of swinging automatic entrances on doors with electric locking. Integrate swinging automatic entrances with other systems as required for a complete working installation.
   2. Where required for proper operation, provide a time delay relay to signal automatic door operator to activate only after electric lock system is released.
   3. Electrical System Roughing-in: Coordinate layout and installation of swinging automatic entrances with connections to, power supplies and remote activation devices. Review details and conditions prior to ordering material.

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1.7 SUBMITTALS

A. General:
   1. Submit in accordance with Division 01.

B. LEED Submittals:
   1. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include achieving LEED v4 Certification. Refer to Section 01 81 13 "Sustainable Design Requirements" for the Project's target certification level and specific LEED requirements. The Contractor shall ensure that the requirements related to the Project's sustainability design goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project's sustainability goals and LEED certification.
   2. EPD/LCA Documentation: Provide a publicly available Environmental Product Declaration in conformance with standards listed and described in Section 01 81 13 "Sustainable Design Requirements."
   3. Manufacturer Take-back Documentation: Provide documentation of the manufacturer's take-back program as defined in Section 01 81 13 "Sustainable Design Requirements."
   4. Regional Sourcing Documentation: Provide a product data sheet or manufacturer affidavit demonstrating regional sourcing as defined in Section 01 81 13 "Sustainable Design Requirements."
   5. Recycled Content Documentation: Provide a product data sheet or manufacturer affidavit noting the pre-consumer (post-industrial) and post-consumer recycled content value of the product or product components in accordance with requirements described in Section 01 81 13 "Sustainable Design Requirements."

C. Pre-Hardware Schedule:
   1. Report all prevailing conditions that will adversely affect satisfactory execution of work. Examine existing doors and/or frames scheduled for hardware replacement.

D. Submit a detailed door and hardware schedule according to the following:
   1. Hardware Schedule:
      a. Submit hard copies of hardware schedule (number of copies per Division 01) as well as submit editable, PDF files via electronic email of ftp site process in vertical format as illustrated by the Sequence of Format for the Hardware Schedule as published by the Door and Hardware Institute. Schedules which do not comply will be returned for correction before checking. Horizontal-type schedules will be returned for correction before checking.
      b. Hardware schedule shall clearly indicate each hardware group specified and manufacturer of each item proposed.
   2. Provide two copies of illustrations from manufacturer's catalogs and data in brochure form.

3. Wiring Information: Provide manufacturers' wiring information including manufacturers' door elevation diagrams for electrified hardware based on Door Hardware Institute (DHI) core class "Electrified Architectural Hardware" DHI class #COR133. Openings where only magnetic hold-opens or door position switches are specified do not require wiring information. Provide information with hardware schedule submittal for review. Provide detailed wiring diagrams with hardware delivery to jobsite.
4. Review of schedules does not relieve the Contractor of providing all hardware required for the Work, whether or not such hardware was inadvertently omitted from Submittal.

E. Templates:
1. Provide listing of manufacturer's template numbers for each item of hardware in hardware schedule.
2. Submit templates and "Reviewed Hardware Schedule" to door and frame supplier and others as applicable to enable proper and accurate sizing and locations of cutouts and reinforcing.

F. Installation Instructions:
1. Provide manufacturer's written installation and adjustment instructions for finish hardware.
2. Send installation instructions to site with hardware.

G. Contract Closeout Submittals (include specific requirements indicated):
1. Operating and maintenance manuals.
a. Complete information in care, maintenance, and adjustment, data on repair and replacement parts, and information on preservation of finishes.
b. Catalog pages for each product.
c. Name, address, and phone number of local representative for each manufacturer.
d. Parts list for each product.
e. Copy of final accepted hardware schedule, edited to reflect "As installed".
2. Copy of final keying schedule.
3. Maintenance data and devices:
a. Submit two copies of operator maintenance manuals that include the following items:
1) Lubrication instructions.
2) Operator maintenance instructions.
b. Provide special wrenches and tools applicable to each different or special component.
c. Provide maintenance tools and accessories supplied by manufacturer.

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1.8 QUALITY ASSURANCE

A. Operator Device Supplier Qualifications: Firm specializing in the supply and servicing of institutional and commercial low energy operator devices and sliding automatic doors; accredited by manufacturers; and having a minimum of 3 years documented experience. Hardware supplier to furnish list of at least 10 completed projects complete with date competed, project location and project contact information.

B. Manufacturer Qualifications and Documentation:
   1. Operator Device Manufacturer Qualifications: Manufacturer specializing in manufacturing institutional and commercial high and low energy operator devices with a minimum 5 years with the following documented experience. Furnish list of at least 10 projects (past, finished projects). Include date competed, project location and references (past project contact information to determine if commercial high and low energy operator devices are acceptable).
   2. Manufactured devices submitted must have a factory certified central dispatch service for warranty. System to be available 24 hours a day, 365 days per year to obtain malfunction information and dispatch appropriate service agency to the customer location.

C. Installer Qualifications and Documentation:
   1. Company specializing in installing the products specified in this Section shall have minimum ten years experience and be a member of the American Association of Automatic Door Manufacturers (AAADM). A completed AAADM compliance form shall be submitted as proof of compliance with current ANSI/BHMA 156.19 American National Standard for power high and low energy operated doors as well as high energy operators. Doors shall be inspected and form shall be signed by an AAADM certified inspector prior to placing doors in operation.
   2. Operator Device Installer qualifications: The installer of assembly shall be trained in the trade of installing and start-up of commercial high or low energy operator devices and sliding automatic doors. Supplier and Installer of door assemblies shall be authorized representative of manufacturers and have minimum of 5 years successful experience in detailing, supplying and installing commercial high and low energy operator devices and sliding automatic doors specified on projects of similar size, complexity and type to this Project.
   3. Local certified distributor to install operator in accordance with current ANSI/BHMA 156.19 American National Standard for High and Low Energy Power Operated Doors and local applicable codes. For low energy applications, local certified distributor to install operator in accordance with ANSI 156.19, ANSI 117.1, NFPA 101 and local applicable codes.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of Division 01.

B. Deliver products in manufacturer's original containers, dry and undamaged, with seals and labels intact.

C. Storage: Store materials in a cool and dry location, elevated from the ground and protected from the elements, and secured from theft or pilferage.

1.10 WARRANTY

A. Comply with provisions of Division 01.

B. Unless otherwise specified below, furnish to Owner a written manufacturer’s 2 year extended guarantee for automatic door operators against defects in materials and workmanship.

PART 2 - PRODUCTS

2.1 MATERIALS: GENERAL REQUIREMENTS

A. The Specifications are intended to cover all doors in the Project and establish a type and standard of quality, but it is the responsibility of the Contractor to furnish proper hardware for all openings and for a complete installation. Where Hardware Groups/Sets have different information refer to the following specifications for clarification and detailed requirements (provide all devices whether specified or not in hardware sets/groups).

2.2 FINISH

A. Typical BHMA finish designation references (provide hardware groups/sets devices/finishes, along with added finishes below, as indicated on drawings and detailed requirements for each type of device):
   1. BHMA 628: Aluminum, clear anodized.
   2. BHMA 626: Satin chromium plated brass or bronze.
   3. BHMA 630 satin stainless steel.

2.3 HARDWARE TEMPLATE

A. Promptly furnish template information or templates to door and frame manufacturers.

B. Coordinate hardware items to prevent interference with each other.

2.4 FASTENINGS

A. Fastenings shall match hardware material and finish.

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B. Use screws, bolts, washers, grommets, nuts, and other fastening devices of appropriate size, length, type, head, metal and finish as necessary for proper match and application of hardware Machine screws and tamping shields for attaching hardware to concrete, stone, or masonry.

C. Provide nonferrous or corrosion-resistant steel fasteners exposed to weather.

2.5 SUBSTITUTIONS

A. Products referenced by specific brand names and model numbers have been identified by Owner to match other products in use either completed or in the course of completion. No substitutions permitted per Public Contract Code Section 3400.
   1. Otherwise refer to Division 01 for substitutions.

2.6 LOW ENERGY AUTOMATIC OPERATOR DEVICES

A. Overhead mounted devices:
   1. Condor Series x battery backup system by Motion Access Manufacturing
      a. Provide 180-degree swing as detailed in 08 71 13.Part 3 sets or equal by Horton (4900LE series or Stanley M series 180-degree units).
      b. Provide complete Cyberpower #DS CP425SLG or modern battery backup. All components required to complete the work in accordance with specifications and intended operation including battery backup system to meet CBC 2022 (Cyberpower or externally mounted will be approved if engineered by 08 7 13 Vendor's engineering group prior to submittals).

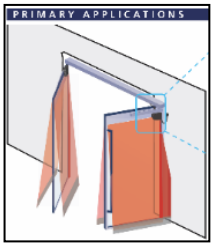
B. Contract directly with member of the American Association of Automatic Door Manufacturers (AAADM, not as a sub-contract to the door supplier).

C. Where Hardware Groups/Sets have different information refer to the following specifications for clarification and detailed requirements:
   1. Drop Plates, Brackets or Adapters (see snippet below with filler plate example):
      a. Provide complete drop plates / brackets as required to suit details.
      b. Do not install auto operators with space remaining between the wall and auto operator body. Provide non-ferrous, galvanized metal shims and/or metal space blocking between auto operator body and wall conditions.
      c. Finished surface and edges of backer plates shall be smooth and dry Backer rods and finish sealants are only allowed where primer and paint can be applied so that daily cleaners can be utilized to clean surfaces without cleaners stripping sealants and/or paints.
   2. Provide required relays and devices as part of the overall system in accordance system requirements. Units shall have relay contact for interfacing products. Door operator shall have input line rating of 120VAC.unit shall have an internal circuit breaker switch to interrupt input power for servicing. Unit shall be U.L. Listed for automatic closing door. Unit shall be in compliance with the requirements of the Americans with disabilities act (ADA) and ANSI standards A117.1 and A156.19.

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3. Provide adjustment for opening, closing, and checking speeds, as well as length of time door remains open.
4. Relays, timer, and logic modules devices: At all auto door operator locations, provide BEA device # BR3 relay, timer, and logic modules (required for interface to indicated security components; and shall be assembled, connected, and fully contained within the power supply enclosure).
5. Relays, timer, and logic modules Devices:
   a. At all auto door operators locations, provide BEA device # BR3 relay, timer, and logic modules (required for interface to indicated security components; and shall be assembled, connected, and fully contained within the power supply enclosure).
6. Safety Sensor Devices:
   a. Design basis of design: BEA manufacturing #10LZRFLATSCAN-SWB x required relays. Safety sensor devices installed on door as shown below (provide installation back plates and devices as required for each type of door/frame condition):



   b. At specified low energy operator locations in hardware sets below, provide one safety sensor device at each leaf.
      1) Safety sensor devices are not to be utilized for opening sensors. Opening actuation by wall mounted push plates or separate infrared presence sensor as scheduled.
      2) Sensor devices are to be active infrared presence/safety sensor. The function of device is to protect the door from closing on a person or object in the swing-area detection zone.
   c. Provide additional lockout module devices as required as some of the newer auto operator device manufacturers have a built-in lockout. Provide a fully functional system to meet design intent. Lockout module is typically determined by the door controller/control box.

D. Push Plates and Touch-Activated Automatic Door Controls:
1. Provide Automatic Operators devices with external Actuators. Card readers also to be utilized at exterior doors where indicated in drawings and as scheduled. Push-and-Go type features are not acceptable.
2. Wave Motion/Touchless Push-Plates (also known as actuator devices), acceptable manufacturers and products: Camden Door Controls manufacturing: “CM-330/42” device as scheduled, or other with wheelchair logo and wording “WAVE TO OPEN”. Switches mounted outdoors or exposed to interior water/humidity shall be mounted with weather resistant integral rubber gasket and back box, supplied by the same manufacturer (provide weather resistant devices that have no gaps for water or ice to penetrate).



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3. Where Hardware Groups/Sets have different information refer to the following specifications for clarification and detailed requirements:
   a. Furnish and install touch-activated automatic door controls with Micro-Switches: double pole, double throw, dry-contact, momentary-action micro-switch.
   b. Furnish and install touch -activated automatic door controls in stainless steel

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(Type 304) finishes with international symbol of accessibility and lettering "push to open" engraved and applied in permanent blue enamel.

c. Mounting: flush-type compatible with touch-activated automatic door controls. Provide complete installation brackets or adapters for automatic operator actuators to suit application.

d. At each location provide two push plates; the centerline of one push plate shall be 7 inches minimum and 8 inches maximum above the floor or ground surface and the centerline of the second push plate shall be 30 inches minimum and 44 inches maximum above the floor or ground surface. Each push plate shall display the international symbol of accessibility.

e. Where pairs of doors have two separate Automatic Operators provide one external On/Off/Hold-Open three-way switch or On/Off two-way switch to control power to both doors/operators.

2.7 POWER SUPPLIES

A. Where Hardware Groups/Sets have different information (number of wires and missing power supply devices and information) refer to the following for clarification and submit according to complete and intended electrified system.

1. Coordinate use of power supplies with door and frame locations. Provide power supplies, relays and battery backup units as part of the overall system in accordance with the manufacturer's warranty and system requirements.
2. Output shall be filtered and regulated. Relay, timer, and logic modules shall be provided as required for interface to indicated security components; and shall be assembled, connected, and fully contained within the power supply enclosure.
3. Provide required connections to fire alarm/life safety system and for remote site activation of all electrified components and functions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The operator installer shall examine the areas and conditions under which the automatic operators are to be installed and notify the Design Professional in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until satisfactory conditions have been corrected.

B. Measurements: Verify all dimensions by taking field measurements before any material is fabricated and shipped to the job site.

3.2 INSTALLATION

A. Install all devices in accordance with manufacturer's printed instructions and approved shop drawings. Install all devices level and plumb.

B. Projecting Items: Install or re-install wrappings furnished by the manufacturer.

C. Coordinate operator installation with electrical connection requirements.

D. Sealants: Furnish and install all sealants indicated or required to complete installation per Division 07.

E. Install equipment per current ANSI/BHMA A156.19 American National Standard for Power Assist and Low Energy Power Operated Doors and as directed by American Association of Automatic Door Manufacturers (AAADM) recommendations.

F. Push plates and touch-activated automatic door controls:
   1. Install touch-activated automatic door controls at mounting height 3 inches above finished floor or as indicated on the Drawings.

   2. Mount touch-activated automatic door controls securely in place to supports with fasteners supplied by manufacturer.

3.3 TESTING, ADJUSTING and INSPECTION

A. Repair or replace installations which do not perform according to manufacturer's printed instructions and approved shop drawings.

B. Adjust parts for smooth, uniform operation. Lubricate moving parts with manufacturer recommended lubricant. Replace units that cannot be adjusted and lubricated to operate freely and smoothly as intended for the application.

C. Adjust door closer devices (inner unit within Auto Operator devices):
   1. Adjust closer operating effort to conform to 2022 CBC Chapter 11B, Section 11B-404.2.9.
      a. Interior and Exterior Doors: Not to exceed 5.0 pounds force.
      b. When fire doors are required, the maximum effort to operate the door may be increased to the minimum allowed by the appropriate administrative authority, not to exceed 15 pounds opening force.
   2. Adjust closer delay and operating speeds to comply with requirements of CBC and Chapter 11B, Part 2, Title 24 CCR and the Americans with Disabilities Act Architectural Guidelines, Article 4.13.10.
   3. Door closers shall have sweep period adjusted so that from an open position of 90 degrees, the time required to move the door to a position of 12 degrees from the latch is 5 seconds minimum per 2022 CBC Chapter 11B, Section 404.2.8.1.

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3.4 CLEANING

A. After repeated operation of completed installation, readjust door operators and controls for smooth, quiet and optimum operating condition and safety. Clean surfaces promptly after installation. Provide protective treatment and other precautions required through the remainder of the construction period to ensure that automatic operators will be without damage or deterioration.

B. Defective Work: Remove and replace any defective work that cannot be properly repaired, cleaned or touched up.

C. Just prior to final acceptance of building or as directed, remove protective paper coverings and clean and polish hardware.

3.5 HARDWARE GROUP/SETS

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B. The following hardware sets are intended to establish type and standard of quality when used together with the requirements of this Section (see above section and related sections including Division 01).

1. Examine Contract Documents and furnish proper hardware for door openings.
2. Refer to Door Schedule on the Drawings for Hardware Group/Set assignments for each opening.

Blank space after a Group/Set is intentional to avoid, if possible,
splitting a Hardware Group/Set onto two pages.

For all doors assigned Hardware Sets #101 on door schedule, provide the following:

Note 1: In addition to the devices specified in hardware group/set below, also coordinate devices in specification Sections 087100 "Door Hardware" (furnish and install doors, frames and related scope per complete Contract Documents):			
2	Ea.	Surface Overhead Low Energy Operator System	Per Section 087113 and the following: Motion Access push-side Condor Swing 90-degree swing series in one continuous case with concealed battery backup or approved equal: - Clear Anodized finish (arms and mounting plates included in matching finishes). - Provide installation plates, arms and covers as required per conditions including, but not limited to deeper frame conditions/reveal and/or hanging devices (hinge as specified in 087100). Show deeper frame conditions/reveal and/or hanging devices in shop drawings during submittals.
2	Set	Safety Sensors (two each leaf)	BEA manufacturing #10LZRFLATSCAN series per above specification x required relays x installation brackets
2	Ea.	Wave Motion /Touchless Automatic Actuators 	#CM-332/42 series device by Camden manufacturing. Part #s of not exact with Camden, see picture and the following descriptions submit correct, all-black #CM-332/42 device: hardwired touchless switch with built-in door control x 2 relays single pole, double throw, dry-contact, momentary-action micro-switch, with wheelchair logo and added text "WAVE TO OPEN"
1	Ea.	Card Reader Side-of-Door (acts as actuator to start auto operators when reader is used)	Card reader acts as the actuator/push-plate on card-reader side of door and starts auto operator (door always locked from card reader side unless authorized card holder uses card reader to enter area)
1	Ea.	Above frame On/Off two-way switch on operator body	On/Off two-way switch per specifications. Coordinate with auto operator manufacturer to verify correct keyed rocker switch size and type for operators installed.
1	Ea.	Relay Device, Various inputs and outputs interface task (required connectivity and required wires)	Provide BEA BR3, 10-BR3 or approved equal relay device: operator vendor/installer to interface all inputs and outputs on the power supply (interfaces to all applicable devices). Vendor to interface all inputs and outputs (including but not limited to power supplies and BR3 devices to all other inputs and output devices)
1	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope (including but not limited to wire / connectivity from ceiling through frame to electrified	By security or electrical as required per Contract Documents: The electrified hardware specified above can be utilized for #1) non-card reader, remote access control applications (unlocked / locked remotely for open during business hours / locked after-hours) and #2) local card readers at openings as directed by architectural drawings, security or electrical. Coordinate with security or electrical Divisions 26 and 28 and applicable drawings as hardware does not include card reader locations.

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		hardware)	
Note 2: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans, and full specification documents.			

Blank space after a Group/Set is intentional to avoid, if possible, splitting a Hardware Group/Set onto two pages.

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For all doors assigned Hardware Sets #102 on door schedule, provide the following:

Note 1: In addition to the devices specified in hardware group/set below, also coordinate devices in specification Sections 087100 "Door Hardware" (furnish and install doors, frames and related scope per complete Contract Documents):			
2	Ea.	Surface Overhead Low Energy Operator System	Per Section 087113 and the following: Motion Access push-side Condor Swing 105-degree swing series in one continuous case with concealed battery backup or approved equal: - Clear Anodized finish (arms and mounting plates included in matching finishes). - Provide installation plates, arms and covers as required per conditions including, but not limited to deeper frame conditions/reveal and/or hanging devices (hinge as specified in 087100). Show deeper frame conditions/reveal and/or hanging devices in shop drawings during submittals.
2	Set	Safety Sensors (two each leaf)	BEA manufacturing #10LZRFLATSCAN series per above specification x required relays x installation brackets
2	Ea.	Wave Motion /Touchless Automatic Actuators 	#CM-332/42 series device by Camden manufacturing. Part #s of not exact with Camden, see picture and the following descriptions submit correct, all-black #CM-332/42 device: hardwired touchless switch with built-in door control x 2 relays single pole, double throw, dry-contact, momentary-action micro-switch, with wheelchair logo and added text "WAVE TO OPEN"
1	Ea.	Card Reader Side-of-Door (acts as actuator to start auto operators when reader is used)	Card reader acts as the actuator/push-plate on card-reader side of door and starts auto operator (door always locked from card reader side unless authorized card holder uses card reader to enter area)
1	Ea.	Above frame On/Off two-way switch on operator body	On/Off two-way switch per specifications. Coordinate with auto operator manufacturer to verify correct keyed rocker switch size and type for operators installed.
1	Ea.	Relay Device, Various inputs and outputs interface task (required connectivity and required wires)	Provide BEA BR3, 10-BR3 or approved equal relay device: operator vendor/installer to interface all inputs and outputs on the power supply (interfaces to all applicable devices). Vendor to interface all inputs and outputs (including but not limited to power supplies and BR3 devices to all other inputs and output devices)
1	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope (including but not limited to wire / connectivity from ceiling through frame to electrified hardware)	By security or electrical as required per Contract Documents: The electrified hardware specified above can be utilized for #1) non-card reader, remote access control applications (unlocked / locked remotely for open during business hours / locked after-hours) and #2) local card readers at openings as directed by architectural drawings, security or electrical. Coordinate with security or electrical Divisions 26 and 28 and applicable drawings as hardware does not include card reader locations.

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Note 2: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans, and full specification documents.

For all doors assigned Hardware Sets #103 on door schedule, provide the following:

Note 1: In addition to the devices specified in hardware group/set below, also coordinate devices in specification Sections 087100 "Door Hardware" (furnish and install doors, frames and related scope per complete Contract Documents):			
2	Ea.	Surface Overhead Low Energy Operator System	Per Section 087113 and the following: Motion Access push-side Condor Swing 90-degree swing series in one continuous case with concealed battery backup or approved equal: - Clear Anodized finish (arms and mounting plates included in matching finishes). - Provide installation plates, arms and covers as required per conditions including, but not limited to deeper frame conditions/reveal and/or hanging devices (hinge as specified in 087100). Show deeper frame conditions/reveal and/or hanging devices in shop drawings during submittals.
2	Set	Safety Sensors (two each leaf)	BEA manufacturing #10LZRFLATSCAN series per above specification x required relays x installation brackets
4	Ea.	Wave Motion /Touchless Automatic Actuators 	#CM-332/42 series device by Camden manufacturing. Part #s of not exact with Camden, see picture and the following descriptions submit correct, all-black #CM-332/42 device: hardwired touchless switch with built-in door control x 2 relays single pole, double throw, dry-contact, momentary-action micro-switch, with wheelchair logo and added text "WAVE TO OPEN"
1	Ea.	Above frame On/Off two-way switch on operator body	On/Off two-way switch per specifications. Coordinate with auto operator manufacturer to verify correct keyed rocker switch size and type for operators installed.
1	Ea.	Relay Device, Various inputs and outputs interface task (required connectivity and required wires)	Provide BEA BR3, 10-BR3 or approved equal relay device: operator vendor/installer to interface all inputs and outputs on the power supply (interfaces to all applicable devices). Vendor to interface all inputs and outputs (including but not limited to power supplies and BR3 devices to all other inputs and output devices)
1	Ea.	Coordination task for electrical design and additional non-Division 08 Section scope (including but not limited to wire / connectivity from ceiling through frame to electrified hardware)	By electrical as required per Contract Documents: Coordinate with electrical Divisions 26 and 28
Note 2: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans, and full specification documents.			

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For all doors assigned Hardware Sets #104 on door schedule, provide the following:

Note 1: In addition to the devices specified in hardware group/set below, also coordinate devices in specification Sections 087100 "Door Hardware" (furnish and install doors, frames and related scope per complete Contract Documents):			
2	Ea.	Surface Overhead Low Energy Operator System	Per Section 087113 and the following: Motion Access push-side Condor Swing 90-degree swing series in one continuous case with concealed battery backup or approved equal: - Clear Anodized finish (arms and mounting plates included in matching finishes). - Provide installation plates, arms and covers as required per conditions including, but not limited to deeper frame conditions/reveal and/or hanging devices (hinge as specified in 087100). Show deeper frame conditions/reveal and/or hanging devices in shop drawings during submittals.
2	Set	Safety Sensors (two each leaf)	BEA manufacturing #10LZRFLATSCAN series per above specification x required relays x installation brackets
4	Ea.	Wave Motion /Touchless Automatic Actuators 	#CM-332/42 series device by Camden manufacturing. Part #s of not exact with Camden, see picture and the following descriptions submit correct, all-black #CM-332/42 device: hardwired touchless switch with built-in door control x 2 relays single pole, double throw, dry-contact, momentary-action micro-switch, with wheelchair logo and added text "WAVE TO OPEN"
1	Ea.	Above frame On/Off two-way switch on operator body	On/Off two-way switch per specifications. Coordinate with auto operator manufacturer to verify correct keyed rocker switch size and type for operators installed.
1	Ea.	Relay Device, Various inputs and outputs interface task (required connectivity and required wires)	Provide BEA BR3, 10-BR3 or approved equal relay device: operator vendor/installer to interface all inputs and outputs on the power supply (interfaces to all applicable devices). Vendor to interface all inputs and outputs (including but not limited to power supplies and BR3 devices to all other inputs and output devices)
1	Ea.	Coordination task for electrical design and additional non-Division 08 Section scope (including but not limited to wire / connectivity from ceiling through frame to electrified hardware)	By electrical as required per Contract Documents: Coordinate with electrical Divisions 26 and 28
Note 2: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans, and full specification documents.			

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For all doors assigned Hardware Sets #105 on door schedule, provide the following:

Note 1: In addition to the devices specified in hardware group/set below, also coordinate devices in specification Sections 087100 "Door Hardware" (furnish and install doors, frames and related scope per complete Contract Documents):			
2	Ea.	Surface Overhead Low Energy Operator System	Per Section 087113 and the following: Motion Access push-side Condor Swing 105-degree swing series in one continuous case with concealed battery backup or approved equal: - Clear Anodized finish (arms and mounting plates included in matching finishes). - Provide installation plates, arms and covers as required per conditions including, but not limited to deeper frame conditions/reveal and/or hanging devices (hinge as specified in 087100). Show deeper frame conditions/reveal and/or hanging devices in shop drawings during submittals.
2	Set	Safety Sensors (two each leaf)	BEA manufacturing #10LZRFLATSCAN series per above specification x required relays x installation brackets
2	Ea.	Wave Motion /Touchless Automatic Actuators 	#CM-332/42 series device by Camden manufacturing. Part #s of not exact with Camden, see picture and the following descriptions submit correct, all-black #CM-332/42 device: hardwired touchless switch with built-in door control x 2 relays single pole, double throw, dry-contact, momentary-action micro-switch, with wheelchair logo and added text "WAVE TO OPEN"
1	Ea.	Card Reader Side-of-Door (acts as actuator to start auto operators when reader is used)	Card reader acts as the actuator/push-plate on card-reader side of door and starts auto operator (door always locked from card reader side unless authorized card holder uses card reader to enter area)
1	Ea.	Above frame On/Off two-way switch on operator body	On/Off two-way switch per specifications. Coordinate with auto operator manufacturer to verify correct keyed rocker switch size and type for operators installed.
1	Ea.	Relay Device, Various inputs and outputs interface task (required connectivity and required wires)	Provide BEA BR3, 10-BR3 or approved equal relay device: operator vendor/installer to interface all inputs and outputs on the power supply (interfaces to all applicable devices). Vendor to interface all inputs and outputs (including but not limited to power supplies and BR3 devices to all other inputs and output devices)
1	Ea.	Coordination task for security and/or electrical design and additional non-Division 08 Section scope (including but not limited to wire / connectivity from ceiling through frame	By security or electrical as required per Contract Documents: The electrified hardware specified above can be utilized for #1) non-card reader, remote access control applications (unlocked / locked remotely for open during business hours / locked after-hours) and #2) local card readers at openings as directed by architectural drawings, security or electrical. Coordinate with security or electrical Divisions 26 and 28 and applicable drawings as hardware does not include card reader locations.

		to electrified hardware)	
Note 2: Furnish all devices and components for hardware groups/set above in accordance with Contract Documents including, but not limited to, additional hardware devices requirements in the above specification language, architectural plans, and full specification documents.			

END OF SECTION

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SECTION 08 81 10 – INTERIOR GLASS GLAZING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Tempered glass.
   2. Fire-resistant glass ceramic material.
   3. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

B. Related Requirements:
   1. Section 08 83 13 for mirrored glass.

1.2 REFERENCES

A. Definitions:
   1. Manufacturer: Means the primary glass manufacturer, unless otherwise indicated.
   2. Fabricator: Means the secondary glass fabricator, unless otherwise indicated.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Performance Requirements:
   1. Minimum Glass Bite Depth: At least 3/8-inch glass bite depth for 6mm (nominal 1/4-inch) monolithic lites, unless otherwise indicated.
   2. Minimum Edge Clearance: At least 1/4-inch for 6mm (nominal 1/4-inch) monolithic lites, unless otherwise indicated
   3. Minimum Face Clearance: At least 1/8-inch inch for 6mm (nominal 1/4-inch) monolithic lites, unless otherwise indicated.
   4. Safety Glazing Requirements: Provided either fully tempered or laminated glass conforming to ANSI Z97.1 requirements for Drop Height Class A wherever safety glazing is indicated or required. Wire glass is prohibited.
   5. Other Requirements: Installed glass must be free from rattle.

1.4 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).

1. Product Data: Submit manufacturer's product data, specifications, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs) and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
2. Glazing Schedule: Submit glazing schedule indicating glazing types, locations, sizes, thicknesses, and extents.
3. Samples: Submit at least 8-inch square representative samples of each glass type, color, finish, and variety.

B. Informational Submittals: Submit written descriptions confirming experience specified in QUALITY ASSURANCE article below.

1.5 QUALITY ASSURANCE

A. Source Limitations: Glazing must be obtained through one source from the same manufacturer (to ensure compatibility, regulatory conformance, and a warrantable installation).
1. Certain items may be obtained from more than one manufacturer, but only when used for separate installations.
2. Items provided for each different installation must be obtained from the same source and manufacturer.

B. Safety Glazing Certification:
1. Each pane of safety glass delivered to the project site must be furnished with a permanent identification label or mark that identifies the labeler and indicates that safety glazing material is utilized for the installation. Each label must be permanently affixed in a location such that the label remains visible after the pane of glass is installed.
2. Each pane of tempered glass delivered to the project site must be furnished with a permanent identification label or mark etched or ceramic-fired onto the glass surface that identifies the manufacturer or fabricator and indicates that tempered glass is utilized for the installation. Each label or mark must be permanently affixed in a location such that the label or mark remains visible after the pane of glass is installed.

C. Qualifications:
1. Manufacturer: Company or individuals must have at least 10 years' experience manufacturing glazing installed on at least 200 previous projects similar to this project in size, material, design, and complexity.
2. Fabricator: Company or individuals must have at least 10 years' experience fabricating glazing installed on at least 100 previous projects similar to this project in size, material, design, and complexity.
3. Installer: Company or individuals must have at least 5 years' experience installing glazing for at least 30 previous projects similar to this project in size, material, design, and complexity.

4. Supervisors: Individuals must have at least 7 years' experience installing glazing for at least 30 previous projects similar to this project in size, material, design, and complexity, including at least 2 years' supervisory experience directing and leading glazing installers.

1.6 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
   1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
   2. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items as shipped and in conformance with manufacturer's instructions and other requirements and recommendations for storage. Furnish adequate dunnage and bracing during storage.
   1. Prevent stored items from contacting the floor or ground, from soiling and staining, and from deterioration and damage.
   2. If items are not stored in an enclosed location, then cover the tops and sides with securely-tied, waterproof, and breathable covers. Unvented polyethylene tarpaulins do not qualify as breathable covers and are prohibited. (due to potential accumulation of moisture beneath tarpaulin during certain environmental conditions)
   3. Incline covered items to ensure maximum drainage of accumulated moisture.
   4. Do not leave items uncovered where they might be exposed to weather or become wet; or exposed to other sources of deterioration and damage.

C. Handling: Handle items in conformance with manufacturer's instructions and other requirements and recommendations, and in a manner that that prevents damage.

D. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective glass with undamaged new glass that do not exhibit deterioration, damage, or defects.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

PART 2 - PRODUCTS

2.1 PRIMARY GLASS MANUFACTURERS

A. Manufacturers: Provide products manufactured by one of the following, or equal.
   1. Guardian Industries Corp.
   2. Pilkington North America, Inc.
   3. PPG Industries.

4. Saint-Gobain Corp.

2.2 MANUFACTURED GLASS

A. Ultra-Clear (Low Iron) Annealed Vision Glass:
   1. Description: ASTM C 1036, Type I (transparent flat glass), Class 1 (clear), Quality Q3 (select glazing applications).
   2. Products: Provide one of the following, or equal.
      a. “Starphire” manufactured by PPG Industries.
      b. “UltraWhite” manufactured by Guardian Industries Corp.
      c. “OptiWhite” manufactured by Pilkington North America, Inc.
      d. “DIAMANT” manufactured by Saint-Gobain Glass.
   3. Performance Requirements:
      a. Visible Light Transmittance (VLT): At least 90 percent at 6mm thickness.

2.3 SECONDARY GLASS FABRICATORS

A. Fabricators: Provide products fabricated by one of the following, or equal.
   1. Oldcastle BuildingEnvelope Corp.
   2. PPG Industries.
   3. Viracon, Inc.

2.4 TEMPERED GLASS

A. Description: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated surfaces), fabricated from ultra-clear (low iron) annealed vision glass.

B. Minimum Surface Compression Strength: At least 10,000 pounds per square inch.

C. Fabrication:
   1. Fabricate tempered glass by the horizontal (roller hearth) process with roll wave distortion parallel to the bottom glass edge when installed, unless otherwise indicated.
   2. Glazing materials must be free from bubbles, smoke vanes, air holes, scratches and other defects, having ground and arrised edges; provide polished edges where exposed.

D. Source Quality Control:
   1. Individual tempered glass lites installed overhead, and floor-to-ceiling tempered glass lites installed adjacent to walking surfaces must be fully heat soak tested by the manufacturer or fabricator before delivery to the project site.
   2. Other tempered glass lites may have statistical heat soak testing performed to demonstrate nickel sulfide breakage does not exceed 0.1 percent.

2.5 FIRE-RESISTANT GLASS CERAMIC MATERIAL

A. Description: Clear and wireless fire- and impact safety-rated glass ceramic material conforming to ANSI Z97.1 and CPSC 16CFR1201 (Cat. I and II) with high performance surface-applied fire-rated film.

B. Products: “FireLite NT” manufactured by Technical Glass Products (TGP), or equal.

C. Requisite Properties:
   1. Fire-Resistance Rating: 20 minutes to180 minutes with fire hose test.
   2. Thickness: 5mm (nominal 3/16-inch).
   3. Surface Grade: Premium.
   4. Identification: Each fire-rated glazing panel must be labeled with a permanent logo indicating the name of product, manufacture, testing laboratory (UL), fire rating period, safety glazing standards, and date of manufacture.

2.6 ACCESSORIES

A. Shoes for Butt Joint Glazing Installations:
   1. Description: Brushed stainless steel wide U-channel with top load roll-in glazing gasket for 3/4- glass.
   2. Product: “Catalog No. NH3BSCL” manufactured by C.R. Laurence, or equal.
   3. Finish: Brushed stainless steel finish.

B. Shims: Continuous shims fabricated from load-bearing, non-leaching, high-impact polystyrene.

C. Setting Blocks: Elastomeric silicone rubber conforming to ASTM C 1115, CH9.

D. Spacers and End Blocks: Provide the following, unless another type, hardness, class, or surface is supplied, required, recommended, authorized, sanctioned, or accepted by the glass installer.

E. Glazing Gaskets: Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
   1. Firm, Dense Gaskets: Elastomeric silicone or EPDM rubber conforming to ASTM C 1115, CH7S2 unless another type, hardness, class or surface is supplied, required, recommended, approved, or accepted by the glass installer.
   2. Soft, Closed Cell Gaskets: ASTM C 509. Provide silicone or EPDM rubber with pre-molded corners.

F. Cleaners, Primers, Sealers: Supplied, required, recommended, or accepted by the manufacturer or fabricator.

G. Other Accessories: Provide other accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification: Verify in-place construction conforms to the manufacturer's requirements or recommendations and satisfies all other conditions that might affect the quality of installation or the durability, appearance, or performance of installed and adjacent items.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.
   2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 INSTALLATION

A. General Requirements:
   1. Install glazing using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
   2. Set glazing true to line; plumb, level, and square without warp or rack; with flush, well-fitted joints; and in alignment with adjacent construction.
   3. Completed work must match approved samples, as accepted by the Architect.
   4. Installed glazing must be warrantable. Do not install, correct, or replace glazing in a manner that is un-warrantable by the manufacturer; or that results in any warranty or guarantee becoming void.

B. Interface with Adjacent Items: Provide materials, components, and accessories normally furnished or necessary to securely attach glazing to supporting construction.

3.3 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including

arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
   1. written descriptions of non-conforming, damaged, and defective work;
   2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
   3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.4 CLEANING

A. Cleaning Work: Clean all visible glazing surfaces in a manner that does not result in any warranty or guarantee becoming void. Clean spills, stains, soiling, overspray, and fallout from adjacent surfaces.
   1. Use cleaning materials, equipment, and accessories supplied, and means, methods, techniques, and procedures required, recommended, or accepted by the manufacturer.
   2. Do not use cleaning materials or procedures known to change, or that might change, the appearance of exposed finishes or adjacent surfaces; or cause deterioration or damage to exposed finishes or adjacent surfaces.
   3. Protect adjacent surfaces not being cleaned from staining, deterioration, damage, or other detrimental effects caused by cleaning.
   4. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be cleaned to the Architect's acceptance.

B. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

3.5 PROTECTION

A. Protect installed glazing in place from deterioration and damage until Substantial Completion.

B. Do not store anything adjacent to or against installed glazing unless it is protected from damage, as accepted in writing by the manufacturer's representative. Do not use installed glazing surfaces as work surfaces.

C. Remove protection when it's no longer needed and before Substantial Completion.

END OF SECTION

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SECTION 08 83 13 – MIRRORED GLASS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Mirrored glass.
   2. Mirror hardware.
   3. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

1.2 REFERENCES

A. Definitions:
   1. Manufacturer: Means the mirrored glass manufacturer, unless otherwise indicated.

1.3 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data:
      a. Submit manufacturer's product data, specifications, typical installation details, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs) and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
      b. Submit sample warranties with warranty periods, terms, conditions, exclusions, and remedies explicitly defined for each warranty, including clear warranty period start dates. (e.g., date of manufacture, purchase, installation, Beneficial Occupancy, Substantial Completion, Final Completion, etc.)
   2. Shop Drawings: Include project-specific dimensioned details drawn to scale showing conditions not detailed on the product data; or that are detailed, but not in a manner specific to the project.
   3. Samples: Submit at least 8-inch long representative samples of each mirrored glass hardware type, color, finish, and variety.

B. Informational Submittals: Submit manufacturer's instructions for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).

1. Submit manufacturer-prepared published instructions for proper installation of furnished mirrored glass.
2. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.
3. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.

C. Closeout Submittals: Submit the following to the Architect as a condition of project closeout.
1. Warranty Documentation: Submit final warranties signed by the manufacturer's representative with complete terms indicated for all warranties covering items furnished or installed under this specification section.

1.4 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
2. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items as shipped, upright in their original packaging or containers, indoors within dry, well-ventilated, broom-cleaned, and partially- or permanently-enclosed storage areas. Prevent stored items from contacting the floor or ground and from deterioration and damage.

C. Damaged Item Replacement: Promptly remove and replace items that are deteriorated, damaged, or defective with undamaged new items that do not exhibit deterioration, damage, or defects.

D. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

1.5 WARRANTY

A. Manufacturer Warranty: Furnish to the Owner a written manufacturer warranty for products, components, and accessories against all patent and latent defects, and incipient and catastrophic failure for 10 years.

PART 2 - PRODUCTS

2.1 MIRRORED GLASS

A. Clear Annealed Mirrored Glass:

1. Description: 6.0mm thick (nominal 1/4-inch) silvered annealed monolithic clear glass mirrors conforming to ASTM C 1503, Mirror Stock Sheet (mirrors intended for architectural use and where trimming is required), Quality Q-1 (Mirror Select Quality), Clear Glass Mirrors.
2. Manufacturers: Provide products manufactured by one of the following, or equal.
   a. Guardian Industries.
   b. National Glass Industries.

B. Mirror Backing:
1. Protective Copper Coating: “Paint Mirror Backing Copper” manufactured by Sommer & Maca, or equal.
2. Backing Sealer: “Mirro-Bac” flat black, lead-free, industrial quality mirror backing paint manufactured by Palmer Products, or equal.

2.2 MIRROR HARDWARE

A. Bottom Supporting Angles: “Catalog No. D636A” 1/4-inch standard extruded satin anodized aluminum “J” channels manufactured by C.R. Lawrence Co., or equal.

B. Top Supporting Angles: “Catalog No. D645A” 1/4-inch deep nose extruded satin anodized aluminum “J” channels manufactured by C.R. Lawrence Co., or equal.

2.3 ACCESSORIES

A. Cut Edge Sealer: “CRL Gunther Seal-Kwik” manufactured by C.R. Lawrence Co., or equal.

B. Setting Blocks: “Catalog No. PSB040” clear plastic setting blocks manufactured by C.R. Lawrence Co., or equal.

C. Fasteners: Provide countersunk or flat head duplex anti-corrosive steel screw fasteners .

D. Mounting Adhesive Primer: “CRL Gunther Prime-N-Seal Primer” manufactured by C.R. Lawrence Co., or equal.

E. Mounting Adhesive: “CRL Gunther Ultra/Bond Mastic” manufactured by C.R. Lawrence Co., or equal.

F. Other Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification: Verify in-place supporting and adjacent construction conforms to the manufacturer's requirements or recommendations and satisfies all other conditions that might affect the quality of installation or the durability, appearance, or performance of installed and adjacent items.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.
   2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 INSTALLATION

A. General Requirements:
   1. Install mirrored glass using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
   2. Set items true to line, to required levels and lines, and plumb, level, and square, without warp or rack, with flush well-fitted joints, and in alignment with adjacent construction
   3. Installed mirrored glass must be warrantable. Do not install, correct, or replace mirrored glass in a manner that results in any warranty or guarantee becoming void.

B. Interface with Adjacent Items: Provide materials, components, and accessories normally furnished or necessary to securely attach mirrored glass to supporting construction.

C. Installation Tolerances: Install mirrored glass to an allowable tolerance variation of not more than 1/4-inch from true position and not more than 1/8-inch from plumb, level, and alignment.

3.3 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
   1. written descriptions of non-conforming, damaged, and defective work;
   2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
   3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.4 CLEANING

A. Cleaning Work: Clean all visible mirrored glass surfaces in a manner that does not result in any warranty or guarantee becoming void.
   1. Use cleaning materials, equipment, and accessories supplied, and means, methods, techniques, and procedures required, recommended, or accepted by the manufacturer.
   2. Do not use cleaning materials or procedures known to change, or that might change, the appearance of exposed finishes or adjacent surfaces; or cause deterioration or damage to exposed finishes or adjacent surfaces.
   3. Protect adjacent surfaces not being cleaned from staining, deterioration, damage, or other detrimental effects caused by cleaning.
   4. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be cleaned to the Architect's acceptance.

B. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

3.5 PROTECTION

A. Protect installed mirrored glass in place from soiling, deterioration, and damage until Substantial Completion.

B. Do not store anything on or adjacent to or against installed mirrored glass unless they are protected from damage, as accepted in writing by the manufacturer's representative. Do not use installed mirrored glass as work surfaces.

C. Remove protection when it's no longer needed and before Substantial Completion.

END OF SECTION

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DIVISION 09

FINISHES

SECTION 09 05 16– PREPARATION OF CONCRETE SUBSTRATES FOR FINISH FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Concrete substrate testing equipment.
   2. Corrective (remedial) MVECS.
   3. Surface preparation.
   4. Site tests and inspections.
   5. Supplementary components, accessories, and detail work normally furnished or otherwise necessary for complete testing and preparation, whether or not such items are indicated on the Drawings or included in the Specifications.

B. Related Requirements:
   1. Section 03 54 16 for definition of the term “underlayment”.
   2. Section 09 29 00 for definition of “permanent enclosure”.

1.2 RELATED DOCUMENTS

A. This specification section
   1. supplements the requirements of specification sections that identify penetrants, overlays, and coverings required for the project; and
   2. is used with other specification sections to produce correct and complete substrates for all actual in-service flooring conditions applicable to the project; and sound substrates for the proper and warrantable installation of all specified or selected penetrants, overlays, and coverings, including underlayment specified in Section 03 54 16.

1.3 PRICE AND PAYMENT PROCEDURES

A. Slab Remediation:
   1. Without reimbursement from Owner, perform or arrange and pay costs for performing all remedial work necessary to correct and improve
      a. defective flatwork, including areas that exceed the MVER, pH, and RH limits required, recommended, or accepted by the penetrant, overlay, and covering manufacturers; and
      b. penetrant, overlay, and covering failures resulting from selected concrete curing methods; and coordination of, or failure to coordinate, the chemical and adhesive compatibility of selected curing compounds with all subsequent penetrants,

overlays, and covering materials, including primers, adhesives, and sealants, and other installation materials.

2. For other applications, specified MVECS is excluded from the Contract and used only as a topical remediation where necessary to conform to the penetrant, overlay, and covering manufacturers' MVER, pH, and RH requirements.

B. Unit Prices:
   1. Administrative Requirements:
      a. Supply unit prices in terms of dollars per square foot for complete MVECS surface preparation and installation.
      b. Specified MVECS becomes part of the Contract upon acceptance in writing by the Owner via properly-executed Change Order.
   2. Measurement Procedures: Contract adjustments are made based on the net installed verifiable quantities of conforming work compared to quantities indicated on the Drawings.
   3. Payment Procedures:
      a. The Owner provides payment based on actual quantities and measurements that are both placed in the work and verified by the Architect.
      b. The Owner is not required to provide additional compensation for extraneous, non-conforming, or rejected work.

C. Alternates: With input from the preventative (day-of-pour) MVECS manufacturer, preventative MVECS may be considered for certain concrete curing applications in lieu of curing compounds; and possibly in lieu of corrective MVECS products specified in this specification section.

1.4 REFERENCES

A. Abbreviations and Acronyms:
   1. CC: Anhydrous Calcium Chloride.
   2. ICRI: International Concrete Repair Institute.
   3. MVECS: Moisture Vapor Emission Control System.
   4. MVER: Moisture Vapor Emission Rate.
   5. pH: Potential of Hydrogen.
   6. RH: Relative Humidity.

B. Definitions:
   1. Floor Preparation: Means to make flatwork surfaces ready to receive finish flooring and suitable for proper bonding of flooring and installation materials, including patching minor holes and saw cuts, sanding, sweeping, and cleaning of conforming substrates.
   2. Floor Repair: Means to fix or mend non-conforming substrates suffering from damage or fault, including grinding, filling, topping, and leveling activities.

3. Moisture Vapor Emission Rate (MVER): Means the amount of moisture emitted from a substrate, expressed as the weight of condensed gas (liquid) in theoretical pounds emitted over 1,000 square feet of floor area during a 24-hour period. MVER is commonly referred to as “pounds” (i.e., “3 pounds” or “3 lb”). Rates range from 0 to 30 pounds per 1,000 square feet per 24 hours.
4. Substrate: Means a recently-cured, hardened, newly-aged, or existing concrete substrate, including cast-in-place, sitecast, and precast concrete floor and deck assemblies, cast underlayment, toppings, repair materials, and similar items.
   a. Floor: Means a slab-on-grade floor assembly.
   b. Deck: Means a suspended floor or roof slab assembly.
5. Penetrant: Means any direct-applied material, product, component, accessory, or other item that can pass into or through substrate surfaces, or enter and diffuse through substrate surface cracks, pores, and other surface defects. Penetrants include water, hardeners, curing compounds, stains, penetrating repellents and sealers, non-sacrificial graffiti-resistant materials, and dry penetrants.
6. Overlay: Means any direct-applied film-forming or high-build material that covers a substrate surface, including cast decks, underlayment, and toppings; dampproofing, waterproofing, and roofing; liquid flashings and sealants; fluid-applied and flooring treatment; terrazzo flooring; and paints, coatings, and film-forming sealers; and sacrificial graffiti-resistant materials.
7. Covering: Means any direct-applied material, product, component, accessory, or other item that is adhered or bonded to a substrate surface, including tile and adhered veneer assemblies; specialty, masonry, wood, resilient and precast terrazzo flooring; carpeting; and unit paving.
8. Cladding: Means any material, product, component, accessory, or other item supported by a framework, which is attached to a sporting construction, including anchored veneer, wall and soffit panels, and exterior plaster assemblies; suspended ceiling assemblies; and free-standing elevated accessible floor and roof paver assemblies.
9. Overburden: Means all materials, components, accessories, and other items installed or placed over a cured substrate, including overlays, coverings, cladding, and vegetated plaza deck and roof assemblies.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting:
   1. MVECS manufacturer’s representative and MVECS installer must attend the preinstallation meeting .
   2. Schedule a separate additional preinstallation meeting between the Contractor, the Architect, penetrant, overlay and covering manufacturers’ representatives and installers, the MVECS manufacturer’s representative and installer, and the entities and individuals responsible for conducting concrete substrate testing.
   3. Hold the meeting after submittal approval and at least 10 business days before beginning installation.

4. During the meeting, review
   a. substrate design and installation, including concrete mix design, water-cement ratio, slab thickness at each test location, below grade VDRs and concrete placement and pour dates;
   b. curing, sealing, or bond breaking compounds used on substrates, along with requirements and techniques used for complete removal of compounds prior to testing and floor covering installation;
   c. trenching, including mix design, water-cement ratio, thickness, and pour dates of concrete or slurry backfill;
   d. bonding agents selected for overlay installation or application;
   e. primers and adhesives selected for covering installation;
   f. qualifications of the testing agency and testing agency personnel that are scheduled to complete testing, and that interpret test results;
   g. calibration and verification of test equipment prior to beginning each round of testing;
   h. HVAC system operation and requirements during testing, including temperature and RH limits;
   i. preparation of testing sites, including procedures to assure slab surfaces are free from any material or substance that may hinder the free release of moisture from the slab;
   j. testing procedures and sequence for each test, including sequence, frequency, and location of test sites;
   k. requirements for testing and inspection reports;
   l. the construction schedule;
   m. temporary procedures required to protect concrete surfaces from re-wetting after initial testing; and
   n. redistribution of moisture within the substrate after floor coverings are applied;
5. Identify and discuss adverse or unfavorable conditions detrimental to testing and floor preparation.
6. Finalize construction schedule.
7. Record significant discussions and distribute meeting minutes. Do not begin installation until disagreements are successfully resolved to the satisfaction of all parties.

B. Quality Standards:
   1. Quality Guideline: Selected concrete surface profiling, preparation, cleaning, and repair must conform to the requirements of International Concrete Repair Institute (ICRI) Guideline No. 310.2R, "*Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair*".
   2. Installation Standard: Concrete surface preparation must conform to the requirements of Journal of Protective Coatings and Linings (JPCL) publication, "*Surface Preparation of Concrete Substrates*".

C. Qualifications:
   1. Substrate Testing: Individuals performing substrate testing must be certified as ICRI Concrete Slab Moisture Testing Technicians, Grade 1 and current in their certification.
   2. Substrate Repair: Individuals performing substrate repair must be certified as ICRI Concrete Surface Repair Technicians, Grade 1 and current in their certification.

D. Sequencing: Begin substrate testing only after
   1. the building is enclosed with a permanent enclosure, including permanently-installed doors, windows, storefronts, curtain walls and similar opening protectives;
   2. “wet work” such as concrete work, plastering, tile installation, and gypsum board finishing are complete and cured and dried to a condition of equilibrium;
   3. testing areas are properly prepared for testing; and
   4. the HVAC system is activated, operating, and maintaining temperatures and RH at anticipated occupancy levels for at least 48 hours prior to and during testing.
      a. If HVAC activation and operation prior to testing cannot be provided within the proposed construction schedule, then close a number of rooms or spaces where conditions can either be brought to anticipated normal conditions or into conformance with the minimum environmental parameters of the specified test standards using commercial equipment and building climate control services.
      b. Provide a recording hygrometer to monitor and record ambient temperature and RH levels for comparison to design occupancy conditions.

E. Scheduling:
   1. Allow sufficient time in the construction schedule to permit concrete to cure and dry, without being re-wetted, for at least 90 days before beginning testing. Substrates re-wetted after initial curing must be permitted to cure and dry for at least 180 days before beginning testing.
      a. If minimum concrete curing and drying time cannot be provided in the construction schedule, assume the specified MVECS must be incorporated into the project as a topical remediation for concrete substrates, and reflect this assumption in the project cost until otherwise directed by the Owner**.**
      b. Forced drying substrates is prohibited.
   2. Allow sufficient time in the construction schedule to permit RH test sites to equalize for at least 72 hours prior to reading equilibrium RH levels.
   3. Testing must be complete and reports submitted at least one week, but not more than 3 weeks, before beginning penetrant, overlay, or covering installation or application.

1.6 SUBMITTALS

A. Action Submittals: Before beginning the work of this specification section, including bulk purchase and delivery of products, submit to the Architect the following for responsive action (formal review and approval).

1. Product Data:
   a. Submit a comprehensive and complete list of proposed and other items specified, required, or otherwise necessary to complete the work of this specification section, including all accessories and similar secondary items normally furnished, required, or otherwise necessary for complete repair, surface preparation, testing, and remediation.
   b. For each item listed, submit manufacturer's product data, specifications, typical installation details for all actual in-service conditions applicable to this project, and any other information necessary to demonstrate conformance with the Contract Documents, excluding Material Safety Data Sheets (MSDSs) and safety data sheets (SDSs), both of which are returned to the Contractor without review.

B. Informational Submittals: Submit to the Architect the following for information (for informal review: responsive action by the Architect, including formal review and approval, is not expected or required, except to record non-conformance with specified requirements).
   1. Installation Instructions: Before beginning the work of this specification section, submit the following.
      a. Submit manufacturer-prepared published instructions for the proper installation of each furnished manufactured item and accessory, including packaging, delivery, storage, handling, surface preparation, installation, adjusting, cleaning, and protection instructions and requirements.
      b. If manufacturer-prepared published installation instructions are either unavailable or do not specifically apply to actual project conditions, then consult with the manufacturer's representative and obtain manufacturer-prepared, project-specific supplemental instructions printed on the manufacturer's company letterhead. Promptly distribute copies to the Architect for examination before beginning the work of this specification section; the Architect may have comments that lead to contract modifications, or to minor changes in the work.
   2. Test Reports: Submit facility floor plan diagrams showing area calculations and locations of each test along with measured test results for each test location.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide products manufactured by one of the following, or equal.
   1. American Moisture Test, Inc.
   2. Vaisala
   3. Wagner Electronics.

2.2 CONCRETE SUBSTRATE TESTING EQUIPMENT

A. Description: Commercially produced and -packaged test kits and equipment delivered to testing sites in factory-sealed wrappings.

B. MVER Testing Kits (CC Moisture Test Kits):
   1. Description: ASTM F 1869-compliant anhydrous calcium chloride moisture vapor testing kits consisting of a sealed dish of anhydrous calcium chloride, a metering dome with gasket, and instructions.
   2. Product: "AMT Calcium Chloride Moisture Test Kit" manufactured by American Moisture Test, Inc., or equal.
   3. Components:
      a. Non-pre-weighed, non-recycled, 94-percent pure anhydrous calcium chloride sealed in air-tight dishes.
      b. Virgin resin non-recycled plastic dome having a maximum U.S. perm rating of 0.10-perm or less.
      c. Butyl adhesive sealant system.
      d. Dish container size of 69mm plus or minus one millimeter; calcium chloride weight of 16 grams plus or minus one gram.

C. pH Testing Kits:
   1. Description: ASTM F 710-compliant digital alkalinity-pH meter.
   2. Product: "AMT Concrete Digital Alkalinity-pH Meter" manufactured by American Moisture Test, Inc., or equal.
   3. Components:
      a. Meter must return wide range (1-14) pH readings.
      b. Provide clean distilled or deionized water.

D. RH Testing Equipment:
   1. Description: ASTM F 2170-compliant temperature and RH meter, cable, RH probes, and concrete sleeves.
   2. Product: "AMT RH System" manufactured by American Moisture Test, Inc., or equal.

2.3 CORRECTIVE (REMEDIAL) MVECS

A. Description: Corrective MVER remediation system consisting of concrete mechanical surface profiling, sealer, and cementitious covering.

B. Application: MVER remediation system are applied when test results indicate slab MVER, pH, or RH exceed selected coating or covering manufacturer's required, recommended, or accepted limits.

C. Concrete Surface Profiling: ICRI concrete surface profile CSP 2 to CSP 3 (grind to light blast between 4 and 10 mils), unless otherwise explicitly required, recommended, accepted in writing by the sealer manufacturer.

D. Sealer:
   1. Description: Moisture seal applied to substrates as a topical remediation.
   2. Products: “MES 100” manufactured by Floor Seal Technology, Inc., or equal.
   3. Requisite Properties:
      a. Composition: Products may not contain latex, organic additives or chemistries that have a potential to either re-emulsify or support micro-organism growth.
      b. Growth Resistance: Product must not support the growth of mold, mildew or biological growth.
      c. Safety: Non-corrosive, non-toxic, and non-hazardous to installers.
      d. Water Pollution: Product must be a non-marine pollutant, and safe for natural water sources.
      e. Maximum VOC Material Content: Less than 100 grams per liter.
   4. Performance Requirements:
      a. Water Vapor Transmission: Products must bring emission rates of up to 20 pounds to within a range conforming to the flooring manufactures’ requirements, when measured in conformance with ASTM F 1869.
      b. Alkali Resistance: Tolerant to 14pH alkali exposure, when tested in conformance with ASTM D 1308 and ASTM F 710.
      c. Minimum Adhesion Strength: Between 370 and 500 pounds per square inch, when tested in conformance with ASTM D 4541.
      d. Adhesive Compatibility: Complete compatibility with all covering primers, adhesive, and materials.
      e. Minimum RH Tolerance: Tolerant to at least 95 percent RH exposure, when determined in conformance with ASTM F 2170.

E. Covering:
   1. Description: Cementitious topping applied directly over sealer to provide smooth substrate for finish flooring.
   2. Products: Hydraulic cement underlayment .
   3. Minimum Thickness: Install underlayment to thickness required by either the sealer manufacturer or the finish flooring manufacturer (whichever is thicker), but not less than 1/8-inch.

2.4 ACCESSORIES

A. Trowelable Patch and Fill Materials: Specified in Section 03 54 16 unless other products are supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

B. Other Accessories: Provide accessories and other similar secondary items supplied, required, recommended, or accepted by the MVECS manufacturer.

2.5 SURFACE PREPARATION

A. Penetrants:
   1. Remove all dirt, dust, debris, and other foreign matter from concrete surfaces

B. Marker Removal:
   1. Remove all slab markings by sanding or bead blasting surface clean.
   2. Completely remove all marker markings (i.e. Sharpie markers), marker paint, spray paint, and other markings.

C. Floor Coatings and Fluid-Applied Flooring:
   1. Provide one or more of the following ICRI concrete surface profiles, as applicable, unless otherwise explicitly required, recommended, or accepted in writing by the flooring manufacturer.
      a. Sealers: CSP 1 to CSP 2. (grind to between 0 and 3 mils)
      b. Thin-Film Coatings: CSP 2 to CSP 3. (grind to light blast between 4 and 10 mils)
      c. High-Build Coatings and Resurfacing Applications: CSP 3 to CSP 5. (light to medium shotblast between 10 and 40 mils)
      d. Self-Leveling Overlays: CSP 4 to CSP 6. (medium to heavy shotblast between 50 mils and 1/8-inch)
      e. Polymer Overlays: CSP 5 to CSP 9. (medium shotblast to coarse planing between 1/8- and 1/4- inch)
      f. Concrete Overlays, Toppings, and Repairs: CSP 5 to CSP 10. (medium shotblast to coarse planing greater than 1/4- inch)
   2. To reduce the risk of introducing microcracking into the substrate, all concrete surface profiling must be achieved through abrasive blasting, grinding, or shot blasting; or through the use of surface retarders.
      a. Handheld concrete breakers, rotomilling, needle scaling, scabbling, and scarifying are prohibited, unless explicitly required or recommended in writing by the covering manufacturer (scarifying grooves/lines may become visible through a newly laid coverings).
      b. Ultra-high- and high-pressure water jetting, and low-pressure water jetting surface preparation methods are also prohibited.
      c. Chemical cleaning and acid etching are also prohibited. (residual chemicals not removed may adversely affect the flooring performance and adhesion – ASTM D 4262 covers procedures for determining the acidity or alkalinity of concrete surfaces prepared by chemical cleaning or etching prior to coating)
   3. Repair damaged sub-floor. Produce a uniform and smooth substrate. Fill cracks, holes, depressions, and similar substrate defects with trowelable leveling and patching compound; remove bumps and ridges.
   4. Sweep and vacuum-clean substrates just prior to beginning floor covering installation.
   5. Move floor coverings and installation materials into spaces at least 48 before installation.

D. Floor Coverings: Prepare substrates in conformance with the requirements of ASTM F 710 and as required, recommended, or accepted by the manufacturer without limitation; and in a manner that does not result in any warranty or guarantee becoming void.
   1. Verify substrates are dry and free of curing compounds, sealers, and hardeners.
   2. Remove substrate coatings and other substances that are incompatible with adhesives or that contain soap, wax, oil, or silicone; or that may negatively affect the quality of installation, durability, appearance, or performance of furnished flooring. Comply with the flooring manufacturers' instructions using manufacturer-recommended techniques and equipment. Do not use solvents.
   3. Remove subfloor ridges and bumps. Fill minor or local low spots, cracks, joints, holes, and other defects with leveling and patching compound. Apply, trowel, and float patching compound to achieve smooth, flat, hard surface. Prohibit traffic until patching compound is cured.
   4. Repair damaged sub-floor. Produce a uniform and smooth substrate. Fill cracks, holes, depressions, and similar substrate defects with trowelable leveling and patching compound; remove bumps and ridges.
   5. Sweep and vacuum-clean substrates just prior to beginning floor covering installation.
   6. Do not install floor coverings until both they and the installation materials are acclimated to the same temperatures as the spaces into which they are installed. Move floor coverings and installation materials into spaces at least 48 before installation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Before beginning testing, examine project conditions and field-verify measurements affecting the work of this specification section.
   1. Examine substrates scheduled for testing, and other conditions under which such items are tested, including HVAC operation and building enclosure.
   2. Verify that work performed as part of the work of other specification sections conforms to the testing equipment or testing kit manufacturer's requirements; and satisfies all other conditions relating to the quality of testing.

3.2 FIELD QUALITY CONTROL

A. Site Tests and Inspections:
   1. General: Include site tests and inspections as part of the work of this specification section. The Owner's testing and inspection agency performs tests and inspections.
      a. Schedule and arrange all tests and inspections.

b. Coordinate all work and the final construction schedule with all tests and inspections.
c. Coordinate tests and inspections with the work of other specification sections, and other specified, required, or necessary tests and inspections.
d. Furnish all work, equipment, tools, facilities, personnel, and controls necessary for each test and inspection.
e. Arrange tests and inspections by notifying the Owner, the testing and inspection agency, the installer, the manufacturer's representative, and the Architect at least 5 business days before work is ready for testing or inspection.
f. Witness all site tests and inspections.
g. Receive test and inspection reports and distribute to the installer and the manufacturer's representative.
h. When tests and inspections reveal defective items, repair defective work to the satisfaction of the manufacturer's representative and Architect, and re-test and re-inspect work without reimbursement from Owner until all work passes tests and inspections.

2. Required Tests: Conduct the following tests on all concrete substrates prior to the installation of any flooring material or component regardless of substrate grade level or age.
   a. MVER Testing (Anhydrous Calcium Chloride Test): Conduct CC tests in conformance with ASTM F 1869.
      1) Test area environmental conditions must match that of the finished floor covering.
      2) Doors, windows, and roofing must be installed and the building temperature controlled to a finished building atmosphere.
      3) Do not perform tests when the interior building temperature is below 65 deg. F for 72 hours prior to and throughout the duration of testing.
      4) The minim required number of test kits is determined by the square footage of areas scheduled to receive finish flooring. Provide at least 3 test kits for the first 1,000 square feet, and at least one additional test kit for each additional 1,000 square feet or fraction thereof, with consideration given to separation of test areas.
      5) Time of exposure must be between 60 hours 72 hours.
      6) Clean substrate in area to be tested by removing dust solvent, paint, wax, oil, grease, residual adhesive, adhesive removers, curing, sealing, hardening, or parting compounds, alkaline salts, excessive carbonation, or laitance, mold mildew and other foreign materials.
      7) Weigh the tape sealed dish on a gram scale with 1/10th gram gradation. Record start weight, date and time on dish's label and instruction document.
      8) Unseal dish and expose test according to preprinted test kit instructions.
      9) After exposure time has elapsed, retrieve test dish re-seal and re-weigh according to the manufacturer's instructions.
      10) Moisture emission rates exceeding 3 pounds may affect coating or covering. Verify permissible RH levels with individual flooring manufacturers.

b. Alkalinity (pH) Testing: Conduct pH test in conformance with ASTM F 710.
   1) Perform tests after abrasive removal of concrete surfaces.
   2) Place several drops of water on a clean portion of the substrate surface; form a puddle approximately one-inch in diameter. Allow the puddle to set for at least 60 seconds, and then insert the digital alkalinity-pH meter probe into the puddle. Allow the meter to calculate results for 15 seconds and record the meter readings.
   3) Concrete substrates must test between pH 8.0 and 10.0 before flooring materials are installed; slabs may not exceed pH 10.0.
   4) Readings exceeding pH 10.0 may affect coating or covering. Verify permissible pH levels with individual flooring manufacturers.

c. RH Probe Test: Conduct *in situ* RH probe testing in conformance with ASTM F 2170
   1) Concrete floor slabs must be at the in-service temperature and the occupied air space above the slab must be at the in-service temperature and RH far at least 48 hours before taking RH measurements in the substrate.
   2) Perform at least 3 tests for the first 1,000 square feet and at least one test for every additional 1,000 square feet or fraction thereof.
   3) At below-grade substrates, choose testing locations within 3 feet of each exterior wall.
   4) Drill probe holes 40 percent down into the slab for slabs drying from the top only; 20 percent into the slab for slabs drying from top and bottom.
   5) Use a vacuum cleaner to remove dust from drilled holes, and allow at least 72 hours for holes to achieve moisture equilibrium within each hole before taking RH measurements.
   6) After the 72-hour equilibrium period, insert probes and allow a 30-minute period for each probe to reach temperature equilibrium before measuring RH.
   7) Use the RH probe to measure the ambient air temperature and RH above the slab in the vicinity of the hole.
   8) RH readings exceeding 75 percent may affect coating or covering. Verify permissible RH levels with individual flooring manufacturers.

3.3 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs, and re-inspection and re-testing costs, without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include

1. written descriptions of non-conforming, damaged, and defective work;
2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

END OF SECTION

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SECTION 09 22 16 – LIGHTGAGE METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Metal furring for supporting interior finish materials.
2. Metal framing for supporting interior partition and ceiling assemblies.
3. Delegated design of metal framing assemblies.
4. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

B. Related Requirements:
1. Section 05 40 00 for cold-formed metal framing, including manufactured (pre-engineered) headers and metal wall backings.
2. Section 09 22 26 for metal suspension systems.

1.2 REFERENCES

A. Abbreviations and Acronyms:
1. BMT: Base Metal Thickness.msg
2. MSG: Manufacturer’s Standard Gage for Sheet Steel.
3. HDG: Hot Dip Galvanized.

B. Definitions:
1. Manufacturer: Means the metal framing manufacturer, unless otherwise indicated.
2. Metal Framing: Means lightgage metal framing.
3. Gage: Means the thickness of sheet metal based on weight measured in pounds per square foot per inch of thickness. For the purposes of this specification, gages are classified the Table below. Minimum thickness indicated in the first column is equivalent to 95 percent of the design thickness and is the minimum acceptable thickness of base metal delivered to the project site.
4. Manufacturers' Standard Gage for Sheet Metal: Means the steel sheet thickness based on a weight of 41.82 pounds per square foot per inch of thickness.
5. Base Metal Thickness: Means the thickness of sheet steel material without any coatings.
6. Lightgage Metal Framing: Means metal framing members having a BMT of 30 mils BMT (MSG 20) or less and installed in non-load bearing interior construction assemblies typically supporting plaster or gypsum board.

7. Cold-Formed Metal Framing: Means metal framing members having a BMT range of between 118 mils BMT (MSG 10) and 33 mils BMT (MSG 20) and installed in transverse or axial load-bearing applications, or in non-load bearing interior construction assemblies typically supporting plaster or gypsum board.

Reference Gage	Minimum Thickness (mils)	Design Thickness (inch)
Lightgage Metal Framing specified in this specification Section		
25	18	0.0188
22	27	0.0283
20	30	0.0312
Cold-Formed Metal Framing specified in Section 05 40 00		
20	33	0.0346
18	43	0.0451
16	54	0.0566
14	68	0.0713
12	97	0.1017
10	118	0.1242

1.3 ADMINISTRATIVE REQUIREMENTS

A. Delegated Design Requirements:
   1. Where engineering is required, including when manufacturer's loading tables are exceeded, engineer, fabricate, assemble, and install framing that conforms to the profiles indicated and other Contract Document requirements; meets specified performance criteria; and results in structurally sound, and non-corroding assemblies that accommodate, resist, distribute, or transfer in-service loads without incipient or catastrophic failure.
   2. Maintain visual design concept indicated, including sizes, profiles, and alignments. Deviation from visual design concept is non-conforming work and prohibited without prior written acceptance by the Architect.

B. Performance Requirements:
   1. Interior Partition Uniformly Distributed Lateral Live Load: At least 7.5 pounds per square foot.
   2. Design Loads: Interior partitions must also accommodate, resist, distribute, or transfer, as applicable, other loads to which they are subjected, including attachment

of any architectural components, non-structural components, equipment, and similar items.

3. Superstructure Displacement:
   a. Vertical Displacement of Adjacent Stories (Live Load Deflection): Allow for at least 3/4-inch vertical live load structure deflection, unless otherwise indicated on the structural drawings and general notes.
   b. Horizontal Displacement of Adjacent Stories (Interstory Drift): Accommodate design displacement of adjacent stories indicated on the structural drawings and general notes.
4. Seismic Loads: Resist, distribute, or transfer seismic loads indicated on the structural drawings without incipient or catastrophic failure.
5. Perpendicular Deflection (Convexity and Concavity): Framing members may not deflect more than shown in California Building Code Table 1604A.3 or the following, whichever is less, measured normal to the assembly plane. Limit asymmetric wall construction deflection to the most stringent requirement that applies to the assembly.
   a. Construction Supporting Masonry: Not more than L/360.
   b. Construction Supporting Stone: Not more than L/960.
   c. Construction Supporting Plaster: Not more than L/360.
   d. Construction Supporting Gypsum Board: Not more than L/240.
   e. Construction Supporting Tile: Not more than L/360.

C. Acoustic Requirements: Where materials are part of an STC-rated assembly, provide items within the assembly that are identical to or better than those products indicated as listed and tested in conformance with ASTM E 90 and ATM E 413.

1.4 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data: Submit manufacturer's product data, specifications, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs) and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
   2. Shop Drawings: Include project-specific dimensioned details drawn to scale showing framing conditions not detailed on the product data; or that are detailed, but not in a manner specific to the project.

B. Informational Submittals: Submit the following for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
   1. Manufacturer's Instructions: Submit manufacturer-prepared published instructions for proper installation of furnished framing.

a. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.
b. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.

2. Delegated Design Submittals: Together with shop drawings, submit engineering calculations demonstrating conformance to the Contract Documents and all impacts of delegated design scope of work on other work.
   a. Calculations must be explicit and legible and must incorporate distinct cross-references to submitted shop drawings in sufficient quantity to render the calculations readily intelligible and reviewable.
   b. At a minimum, calculations must include design loads; analysis of supporting construction, including section-property computations; analysis of fasteners, anchors, attachments, and connectors; and signature and seal of the licensed professional engineer responsible for preparing them.
   c. Test reports are not an acceptable substitute for calculations and are returned to the Contractor without review or responsive action, except to record non-conformance with this requirement.
3. Qualification Statements: Submit written descriptions confirming experience specified in QUALITY ASSURANCE article below.

1.5 QUALITY ASSURANCE

A. Source Limitations:
   1. Framing must be obtained through one source from the same manufacturer (to ensure compatibility, regulatory conformance, and a warrantable installation).
      a. Certain items may be obtained from more than one manufacturer, but only when used for separate installations.
      b. Items provided for each different installation must be obtained from the same source and manufacturer.
   2. Provide secondary materials, components, accessories and other items from sources required, recommended, or accepted by the primary manufacturer for actual in-service conditions applicable to the project.

B. Quality Standards:
   1. Comply with all requirements of the California Building Code (CBC).
   2. Comply with ASTM C 754 requirements for installation of lightgage metal framing, except conform to the framing sizes and spacing indicated.
   3. Comply with the requirements of ASTM C 840 that apply to framing installation

C. Qualifications:
   1. Installer: Company or individuals must have at least 5 years' experience installing framing for at least 30 previous projects similar to this project in size, material, design, and complexity.

2. Supervisors: Individuals must have at least 7 years' experience installing framing for at least 30 previous projects similar to this project in size, material, design, and complexity, including at least 2 years' supervisory experience directing and leading framing installers.
3. Engineer: Must be a licensed professional structural engineer registered to practice in California having at least 10 years' experience performing the kind of engineering services indicated for at least 20 previous projects similar to this project in size, material, design, and complexity.

1.6 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
   1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
   2. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items as shipped and in conformance with manufacturer's instructions and other requirements and recommendations for storage. Furnish adequate dunnage and bracing during storage.
   1. Prevent stored items from contacting the floor or ground, from soiling and staining, and from deterioration and damage.
   2. If items are not stored in an enclosed location, then cover the tops and sides with securely-tied, waterproof, and breathable covers. Unvented polyethylene tarpaulins do not qualify as breathable covers and are prohibited. (due to potential accumulation of moisture beneath tarpaulin during certain environmental conditions)
   3. Incline covered items to ensure maximum drainage of accumulated moisture.
   4. Do not leave items uncovered where they might be exposed to weather or become wet; or exposed to other sources of deterioration and damage.

C. Handling: Handle items in conformance with manufacturer's instructions and other requirements and recommendations, and in a manner that that prevents damage.

D. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective framing with undamaged new framing that does not exhibit deterioration, damage, or defects.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide products manufactured by one of the following, or equal.
   1. California Expanded Metal Products Co. (CEMCO)
   2. Clarkwestern Dietrich Building Systems LLC.
   3. Olmar Supply Inc.
   4. SCAFCO Corp.

2.2 MATERIALS

A. Cold-Formed Metal Framing: ASTM A 1003, ST50 (Structural Grade 50), with at least a G60 coating weight designation (mass designation) on both surfaces with equal coating weight on each surface.

B. Lightgage Metal Framing: ASTM C 645 manufactured from HDG metallic-coated steel sheet conforming to ASTM A 1003, NS33 (Non-Structural Grade 33), with at least a G40 coating weight designation (mass designation) on both surfaces with equal coating weight on each surface.

2.3 COLD-FORMED METAL FURRING

A. Hat Furring Channels:
   1. Products: “FC Series Furring Channel” manufactured by Clarkwestern Dietrich Building Systems LLC, or equal.
   2. Requisite Properties:
      a. Depth: 7/8- or 1-1/2-inch deep channels, as indicated.
      b. Minimum Thickness: At least 43 mils BMT (MSG 18).
      c. Web: 1-1/4 inches wide.
      d. Screw Flanges: 3/4-inch wide.

B. Z-shaped Furring Channels:
   1. Products: “Z-Furring (ZF-Series)” manufactured by Clarkwestern Dietrich Building Systems LLC, or equal.
   2. Requisite Properties:
      a. Depth: One to 3 inches deep, as indicated.
      b. Minimum Thickness: At least 43 mils BMT (MSG 18).
      c. Screw Flanges: 1-1/4 inches wide.

2.4 LIGHTGAGE METAL FURRING

A. Hat Furring Channels:

1. Products: “Hat” or “F” furring channel manufactured by CEMCO, or equal.
2. Requisite Properties:
   a. Depth: 7/8- or 1-1/2-inch deep, as indicated.
   b. Minimum Thickness: At least 30 mils BMT (MSG 20).
   c. Web: 1-1/4 inches wide or 2-1/2 inches.
   d. Screw Flanges: 1/2-inch wide.

B. Z-shaped Furring Channels:
1. Products: “CEMCO Z - Furring Channel” manufactured by CEMCO, or equal.
2. Requisite Properties:
   a. Depth: 7/8-inch.
   b. Minimum Thickness: At least 30 mils BMT (MSG 20).
   c. Screw Flanges: 1-1/4 inches wide.

C. Standard Resilient Channels:
1. Products: “RC1-X” manufactured by CEMCO, or equal.
2. Requisite Properties:
   a. Depth: 1/2-inch deep.
   b. Minimum Thickness: At least 30 mils BMT (MSG 20).
   c. Screw Flanges: 1-1/4 inches wide.

D. Resilient Channels for Acoustical Applications:
1. Product: “RC Deluxe Resilient Channel (RCSD)” manufactured by Clarkwestern Dietrich Building Systems LLC, or equal.
2. Requisite Properties:
   a. Depth: 1/2-inch deep.
   b. Minimum Thickness: At least 27 mils BMT (MSG 22).
   c. Screw Flanges: 1-1/2 inches wide.

E. Resilient Sound Isolation Clips:
1. Description: Molded rubber and steel resilient sound isolation wall and ceiling clips.
2. Products: Provide one of the following, or equal.
   a. “IsoMax” manufactured by Kinetics Noise Control, Inc.
   b. “RSIC-1” manufactured by PAC International, Inc.
   c. “GenieClip Resilient Sound Isolation Clip” manufactured by Pliteq, Inc.

2.5 LIGHTGAGE STUD FRAMING

A. Studs:
1. Description: Pre-punched C-shaped framing members with manufacturer’s standard knockout sizing and spacing.
2. Product: “Viper Stud” manufactured by CEMCO, or equal.

3. Requisite Properties:
   a. Depth: Indicated on the Drawings.
   b. Minimum Thickness: At least 30 mils BMT (MSG 20).
   c. Flanges: 1-1/4-inch wide stiffened flanges with at least 1/4-inch returns (lip).

B. Tracks (Top and Bottom Runners):
1. Description: Un-punched U-shaped runners manufactured from the same material to corresponding stud sizes and gages.
2. Product: “Viper Track” manufactured by CEMCO, or equal.
3. Requisite Properties:
   a. Depth: Indicated on the Drawings.
   b. Minimum Thickness: At least 30 mils BMT (MSG 20).
   c. Flanges: At least 1-1/4-inch wide unstiffened flanges.

C. High-Performance Studs:
1. Description: Pre-punched C-shaped framing members with manufacturer’s standard knockout sizing and spacing.
2. Product: “Viper-X Stud” manufactured by CEMCO, or equal.
3. Requisite Properties:
   a. Depth: Indicated on the Drawings.
   b. Minimum Thickness: At least 28 mils BMT.
   c. Flanges: 1-7/16-inch wide flanges with at least 3/8-inch returns (lip).

D. High-Performance Tracks (Top and Bottom Runners):
1. Description: Un-punched U-shaped runners manufactured from the same material to corresponding stud sizes and gages.
2. Product: “Viper-X Track” manufactured by CEMCO, or equal.
3. Requisite Properties:
   a. Depth: Indicated on the Drawings.
   b. Minimum Thickness: At least 28 mils BMT.
   c. Flanges: At least 1-1/4-inch wide unstiffened flanges.

E. Deflection Tracks:
1. Description: Slotted roll- or brake-formed track installed in head-of-wall deflection conditions to accommodate vertical movement caused by normal head-of-wall and floor extension or compression.
2. Products: “CEMCO Slotted Track (CST)” or “SLP-TRK” manufactured by CEMCO, or equal.

F. Cold Rolled Channel (CRC) Bridging:
1. Description: Un-punched U-shape stiffeners installed in both load-bearing and non-load bearing walls to help resist stud twisting.
2. Requisite Properties:

a. Size: 1-1/2-inch wide by 1/2-inch deep.
b. Minimum Thickness: At least 54 mils BMT (MSG 16).
c. Flanges: 1-1/2 inches wide unstiffened flanges.

3. Manufactured Bridging Clips: “SUBH Wall Stud Bridging Connectors” manufactured by CEMCO, or equal.

G. Flat Strap Bridging (Strapping):
1. Application: Flat sheet installed to provide resistance to stud rotation and minor axis buckling under loads for studs deeper than 6 inches.
2. Requisite Properties:
a. Width: Between 2 and 20 inches, as indicated or necessary.
b. Minimum Thickness: At least 54 mils BMT (MSG 16).

2.6 SPECIALTY FRAMING

A. Corner Angles:
1. Description: Utility angles installed as a connection strut or angle, as corner reinforcement, or other various framing applications.
2. Requisite Properties:
a. Minimum Thickness: At least 30 mils BMT (MSG 20).
b. Legs: 2- or 3-inch wide legs, as indicated, unless a wider or uneven leg size is explicitly indicated; or is otherwise supplied, required, recommended, authorized, or accepted by the manufacturer.

2.7 ACCESSORIES

A. Partition Closures:
1. Description: Narrow resilient partition termination and sound deterrent manufactured from extruded Silicone conforming to ASTM D 2000, 4GE 709 M.
2. Application: Used at voids between partition ends and exterior curtain walls; must allow exterior glass deflection during positive and negative wind loading.
3. Product: “Rizza PCS” manufactured by Balco, Inc., or equal.
4. Color: Indicated on the Drawings or selected by the Architect.

B. Fire-Rated Partition Closures:
1. Description: Narrow partition termination and sound deterrent manufactured from dual-sided silicone sealing surfaces adhered to fire-retardant impregnated foam backing.
2. Application: Used at voids requiring a fire-resistance rating between partition ends and exterior curtain walls; must allow exterior glass deflection during positive and negative wind loading.
3. Product: “WFR2” manufactured by EMSEAL, or equal.
4. Color: Indicated on the Drawings or selected by the Architect.

C. Mullion Closures:
   1. Description: Factory-assembled, spring loaded, pre-finished aluminum adjustable partition closure.
   2. Application: Used at voids between partition ends and exterior storefront or curtain wall mullions.
   3. Product: “Mullion Mate” manufactured by Gordon, Inc., or equal.
   4. Color: Match curtain wall mullions.

D. Decoupling Sound Isolation Clips: “RSIC-DC04” manufactured by PAC International, LLC, or equal.

E. Resilient Channel Vibration Isolation Clip: “Cylent Assurance Clip” manufactured by Keene Building Products, Inc., or equal.

F. Resilient Partition Isolation Pad:
   1. Description: Molded fiber glass board.
   2. Application: Used to decouples sound-rated partitions from non-isolated structure.
   3. Product: “Wallmat” stud wall isolation strip manufactured by Kinetics Noise Control, Inc., or equal.
   4. Accories: “KAI” isolation bushing assemblies manufactured by Kinetics Noise Control, Inc., or equal.

G. Low Partition Wall Floor Anchors: “Floor Anchor” stud reinforcement manufactured by Pinquist Tool & Die Co., Inc., or equal.

H. Steel Beam and Column Wallboard Clips: “The Claw” beam clips manufactured by Claw International, or equal.

I. Shims: Load bearing, non-leaching, high-density multimonomer plastic.

J. Screw Fasteners: Provide #8-32 UNC 2B (0.164-inch shank diameter, 32 threads per inch) by at least one-inch long, pan head, coarse thread, self-piercing or self-drilling as applicable, chromate finish zinc-plated steel screw fasteners, unless another fastener type is explicitly indicated; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

K. Power-Actuated Fasteners:
   1. Description: ICC-ES-approved anchors conforming to California Building Code Occupancy Category III, Seismic Design Category E, unless a more stringent Occupancy Category or Seismic Design Category is indicated on the Structural Drawings.
   2. Manufacturer: Provide products manufactured by Hilti, Inc., or equal.

L. Fastenings: Provide backings, inserts, loose connection hardware, fasteners, anchors, attachments, connectors, and other items supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

M. Other Accessories: Provide other accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification: Verify in-place supporting and adjacent construction conforms to the manufacturer's requirements or recommendations and satisfies all other conditions that might affect the quality of installation or the durability, appearance, or performance of installed and adjacent items.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.
   2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 INSTALLATION

A. General Requirements:
   1. Install framing using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
   2. Installed framing must be warrantable. Do not install, correct, or replace framing in a manner that results in any warranty or guarantee becoming void.

B. Metal Furring Special Techniques:
   1. Direct Furring: Attach to concrete or to masonry with stub nails, screws designed for masonry attachment, or power-actuated fasteners spaced 24 inches on center.
   2. Z-Furring:
      a. Except at outside corners, securely attach narrow flanges of furring members to walls with concrete stub nails, screws designed for masonry attachment, or power-actuated fasteners spaced 24 inches on center.
      b. At outside corners, attach wide flange of furring members to walls with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.

C. Metal Framing Special Techniques:
   1. Align and securely attach floor and ceiling tracks to superstructure.
   2. Install studs in single lengths extending from floor to underside of floor or roof structure above without joints, except where indicated on the Drawings as stopping at or above ceilings. Stud splicing is prohibited without prior written authorization from the Architect.
      a. Install studs so that flanges within framing systems point in same direction.
      b. Continue framing around ducts that penetrate partitions above ceilings.
      c. Where framing extends to overhead structural supports, install vertical deflection connectors to produce joints at tops of framing assemblies that prevent axial loading of finished assemblies.
      d. Where studs stop at or above ceilings, brace not more than every fourth stud with opposite-side bracing installed at 45-degree angles and securely fastened to the underside of the floor or roof structure above.
      e. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.
      f. Assemble corners using at least 3 studs.
   3. Unless otherwise indicated, provide screw attachment to tracks for
      a. studs with gypsum board on only one side;
      b. studs on each side of doors and windows;
      c. studs supporting wall hung plumbing fixtures; and
      d. studs supporting wall hung urinal screens, toilet compartments, cabinets, equipment, and similar items.
   4. Attach all other studs to tracks either by friction fit for single stud gypsum board partitions or by attaching with screws in conformance with the manufacturer's published installation instructions.
      a. Space anchors within 6 inches of ends of each track segment ends, and not more than 24 inches on center.
      b. Do not install fasteners within 3 inches of slab or curb edges.
   5. Where required by engineering calculations, install horizontal bridging spaced not more than 54 inches on center. Unless otherwise indicated, provide bridging in partitions supporting wall supported cabinets.
      a. Provide an additional 3/4 inch channel 6 inches above door headers, and extend at least 3 studs beyond the jamb studs.
      b. Install channels in longest possible lengths. At end joints, lap at least 12 inches and wire-tie. Do not tie together channels on opposite sides of staggered or double stud partitions.

D. Door and Window Opening Special Techniques:
   1. Provide double studs (installed face to face to form a tube) at locations adjacent to doors and openings.
   2. Extend studs at door openings to slab or deck above and securely anchor both to bottom track and to top slab or deck.

3. Locate additional studs not more than 2 inches from door and window frames, abutting partitions, partition corners, and other construction.
4. Install sections of track over door and window frames with clip angles securely attached at each end to adjacent vertical studs. Install cut-to-length studs at vertical joint locations; and at standard spacing over the door frame header extending to the ceiling track.
5. Install cripple studs at opening heads adjacent to each jamb stud, with at least a 1/2 inch clearance from the jamb stud to allow for installation of control joint in the finished assembly.

E. Other Opening Special Techniques: Unless otherwise indicated, frame other openings and recesses in stud walls the same as that required for door openings.
1. Install framing below sills matching framing required above door heads.
2. Provide additional framing as required for the secure attachment of electrical boxes, fire extinguisher cabinets, and similar items located in stud walls.

F. Interface with Adjacent Items: Provide materials, components, and accessories normally furnished or necessary to securely attach framing to supporting construction.

G. Installation Tolerances: Install framing within the following tolerance variations.
1. Maximum Out of Plumb: Not more than L/960 of span, or 1/8-inch in 10 feet.
2. Maximum Out of Level: Not more than L/960 of span, or 1/8-inch in 10 feet,
3. Maximum Out of Plane: Fastening surfaces of adjacent framing members may not vary by more than 1/8-inch.
4. Maximum Stud Spacing Variance: Not more than 1/8-inch. Cumulative error may not exceed minimum fastening requirements of sheathing or other finishing materials.

3.3 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
1. written descriptions of non-conforming, damaged, and defective work;
2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.4 CLEANING

A. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

END OF SECTION

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SECTION 09 22 26 – METAL SUSPENSION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Metal furring and framing systems for supporting suspended gypsum board ceilings.
   2. Delegated design of metal furring and framing assemblies.
   3. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

1.2 REFERENCES

A. Abbreviations and Acronyms:
   1. BMT: Base Metal Thickness.msg
   2. MSG: Manufacturer's Standard Gage for Sheet Steel.
   3. HDG: Hot Dip Galvanized.

B. Definitions:
   1. Manufacturer: Means the metal suspension system manufacturer, unless otherwise indicated.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Delegated Design Requirements:
   1. Where engineering is required, including when manufacturer's loading tables are exceeded, engineer, fabricate, assemble, and install suspension systems that conform to the profiles indicated and other Contract Document requirements; meet specified performance criteria; and result in structurally sound, and non-corroding assemblies that accommodate, resist, distribute, or transfer in-service loads without incipient or catastrophic failure.
   2. Maintain visual design concept indicated, including sizes, profiles, and alignments. Deviation from visual design concept is non-conforming work and prohibited without prior written acceptance by the Architect.

B. Performance Requirements:
   1. Superstructure Deflection and Story Drift: Accommodate design displacement of adjacent stories indicated on the structural drawings.
   2. Seismic Loads: Resist, distribute, or transfer seismic loads indicated on the structural drawings without incipient or catastrophic failure.

3. Perpendicular Deflection (Convexity and Concavity): Drywall support system may not deflect more than L/240, measured normal to the assembly plane.

C. Acoustic Requirements: Where materials are part of an STC-rated assembly, provide items within the assembly that are identical to or better than those products indicated as listed and tested in conformance with ASTM E 90 and ATM E 413.

1.4 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data: Submit manufacturer's product data, specifications, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs) and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
   2. Shop Drawings: Include project-specific dimensioned details drawn to scale showing conditions not detailed on the product data; or that are detailed, but not in a manner specific to the project.

B. Informational Submittals: Submit the following for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
   1. Delegated Design Submittals: Together with shop drawings, submit engineering calculations demonstrating conformance to the Contract Documents and all impacts of delegated design scope of work on other work.
      a. Calculations must be explicit and legible and must incorporate distinct cross-references to submitted shop drawings in sufficient quantity to render the calculations readily intelligible and reviewable.
      b. At a minimum, calculations must include design loads; analysis of supporting construction, including section-property computations; analysis of fasteners, anchors, attachments, and connectors; and signature and seal of the licensed professional engineer responsible for preparing them.
      c. Test reports are not an acceptable substitute for calculations and are returned to the Contractor without review or responsive action, except to record non-conformance with this requirement.
   2. Qualification Statements: Submit written descriptions confirming experience specified in QUALITY ASSURANCE article below.

1.5 QUALITY ASSURANCE

A. Source Limitations:
   1. Suspension system components must be obtained through one source from the same manufacturer (to ensure compatibility, regulatory conformance, and a warrantable installation).

a. Certain items may be obtained from more than one manufacturer, but only when used for separate installations.
b. Items provided for each different installation must be obtained from the same source and manufacturer.

2. Provide secondary materials, components, accessories and other items from sources required, recommended, or accepted by the primary manufacturer for actual in-service conditions applicable to the project.

B. Quality Standards:
1. Comply with all requirements of the California Building Code (CBC).

C. Qualifications:
1. Installer: Company or individuals must have at least 5 years' experience installing suspension systems for at least 30 previous projects similar to this project in size, material, design, and complexity.
2. Supervisors: Individuals must have at least 7 years' experience installing suspension systems for at least 30 previous projects similar to this project in size, material, design, and complexity, including at least 2 years' supervisory experience directing and leading suspension system installers.
3. Engineer: Must be a licensed professional structural engineer registered to practice in California having at least 10 years' experience performing the kind of engineering services indicated for at least 20 previous projects similar to this project in size, material, design, and complexity.

1.6 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
2. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items as shipped and in conformance with manufacturer's instructions and other requirements and recommendations for storage. Furnish adequate dunnage and bracing during storage.
1. Prevent stored items from contacting the floor or ground, from soiling and staining, and from deterioration and damage.
2. If items are not stored in an enclosed location, then cover the tops and sides with securely-tied, waterproof, and breathable covers. Unvented polyethylene tarpaulins do not qualify as breathable covers and are prohibited. (due to potential accumulation of moisture beneath tarpaulin during certain environmental conditions)
3. Incline covered items to ensure maximum drainage of accumulated moisture.
4. Do not leave items uncovered where they might be exposed to weather or become wet; or exposed to other sources of deterioration and damage.

C. Handling: Handle items in conformance with manufacturer's instructions and other requirements and recommendations, and in a manner that that prevents damage.

D. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective suspension system components with undamaged new suspension system components that do not exhibit deterioration, damage, or defects.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide products manufactured by one of the following, or equal.
   1. California Expanded Metal Products Co. (CEMCO)
   2. ClarkDietrich Building Systems.
   3. Olmar Supply Inc.
   4. SCAFCO Corp.

2.2 MATERIALS

A. Cold-Formed Metal Framing: ASTM A 1003, ST50 (Structural Grade 50), with at least a G60 coating weight designation (mass designation) on both surfaces with equal coating weight on each surface.

B. Lightgage Metal Framing: ASTM C 645 manufactured from HDG metallic-coated steel sheet conforming to ASTM A 1003, NS33 (Non-Structural Grade 33), with at least a G40 coating weight designation (mass designation) on both surfaces with equal coating weight on each surface.

2.3 COMPONENTS

A. Galvanized Carbon Steel Wire:
   1. Hanger Wire: At least 0.162-inch diameter (SWG 8).
   2. Diagonal Bracing Wire: At least 0.106-inch diameter (SWG 12).
   3. Tie Wire: At least 0.050-inch diameter (SWG 18).

B. Standard Furring Clips:
   1. Application: Used in lieu of tie wire to attach metal furring channels to 1-1/2-inch U-channels in drop ceiling assemblies.
   2. Restrictions:

a. Clips must be installed on alternating sides of carrying channels. Use tie wire when clips cannot be alternated.
b. Clips must only be used when single-layer gypsum or single-layer veneer plaster base is used. Otherwise use tie wire.

3. Product: “Metal Furring Channel Clips (MFCC)” manufactured by Clarkwestern Dietrich Building Systems LLC, or equal.

C. Resilient Sound Isolation Furring Clips:
1. Application: Used in lieu of tie wire to attach metal furring channels to 1-1/2-inch U-channels in drop ceiling assemblies.
2. Restrictions:
a. Clips must be installed on alternating sides of the 1-1/2-inch channels. Use tie wire when clips cannot be alternated.
b. Clips must only be used when single-layer gypsum or single-layer veneer plaster base is used. Otherwise use tie wire.
c. Carrying channels (U-channels) may not exceed 48-inch on center spacing.
d. Furring channels (hat channel) may not exceed 24-inch on center spacing.
3. Product: “GenieClip C3” manufactured by Pliteq Inc., or equal.

D. Flat Hangers (Straps):
1. Width: At least 2 inches.
2. Minimum Thickness: At least 97 mils BMT (MSG 12).

E. U-Channel or Cold Rolled Channel (CRC) Carrying Channels:
1. Deep: 3/4- or 1-1/2-inches.
2. Minimum Thickness: At least 97 mils BMT (MSG 12).
3. Flanges: 1/2 inch wide.

F. Hat Furring Channels:
1. Products: “Hat” or “F” furring channel manufactured by CEMCO, or equal.
2. Depth: 7/8- or 1-1/2-inch deep, as indicated.
3. Minimum Thickness: At least 30 mils BMT (MSG 20).
4. Web: 1-1/4 inches wide or 2-1/2 inches.
5. Screw Flanges: 1/2-inch wide.

2.4 ACCESSORIES

A. Attachment Devices: Sized for 5 times the design load indicated in ASTM C 635, Table 1, Direct Hung, unless otherwise indicated. Comply with seismic design requirements.

B. Seismic Separation Joints: Provide seismic separation joints at ceiling locations where the contiguous area of non-broken ceiling is 2,500 square feet or greater.

C. Compression Struts:
   1. Cold or hot rolled angles, loadbearing or non-loadbearing studs, EMT or rigid conduit, or black iron.
   2. Cold-rolled steel section with maximum L/R ratio of 200.

D. Screw Fasteners: Provide #8-32 UNC 2B (0.164-inch shank diameter, 32 threads per inch) by at least one-inch long, pan head, coarse thread, self-piercing or self-drilling as applicable, chromate finish zinc-plated steel screw fasteners, unless another fastener type is explicitly indicated; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

E. Power-Actuated Fasteners:
   1. Description: ICC-ES-approved anchors conforming to California Building Code Occupancy Category III, Seismic Design Category E, unless a more stringent Occupancy Category or Seismic Design Category is indicated on the Structural Drawings.
   A. Manufacturer: Provide products manufactured by Hilti, Inc., or equal.

F. Fastenings: Provide backings, inserts, loose connection hardware, fasteners, anchors, attachments, connectors, and other items supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

G. Other Accessories: Provide other accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification: Verify in-place supporting and adjacent construction conforms to the manufacturer's requirements or recommendations and satisfies all other conditions that might affect the quality of installation or the durability, appearance, or performance of installed and adjacent items.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.
   2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 INSTALLATION

A. General Requirements:
   1. Install suspension systems using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
   2. Installed suspension systems must be warrantable. Do not install, correct, or replace suspension systems in a manner that results in any warranty or guarantee becoming void.

B. Interface with Adjacent Items: Provide materials, components, and accessories normally furnished or necessary to securely attach suspension systems to supporting construction.

C. Installation Tolerances: Install suspension systems within the following tolerance variations.
   1. Maximum Out of Plane: Surfaces may not vary by more than 1/8-inch in 10 feet.
   2. Carrying Channel Maximum Out of Level: Not more than 1/8-inch in 12 feet,
   3. Main Runner Maximum Out of Level: Not more than 1/4-inch in 10 feet,
   4. Main Runner Maximum Deflection: Not more than L/360 of span,
   5. Maximum Misalignment of Main Runners: 0.015-inch.
   6. Maximum Misalignment of Intersection Members: 0.020-inch.
   7. Main Runner Bow, Camber, and Twist: Not more than 1/32-inch in 2 feet bow or camber; not more than one degree twist.

3.3 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
   1. written descriptions of non-conforming, damaged, and defective work;
   2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
   3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect’s acceptance.

3.4 CLEANING

A. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

END OF SECTION

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SECTION 09 28 15 – GMF GYPSUM TILE BACKING BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. GMF gypsum backing board.
   2. Installation materials.
   3. Joint treatment materials.
   4. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

B. Related Requirements:
   1. Section 09 29 00 for requirements for marking and identification of wall and partition construction required to have protected openings or penetrations.

1.2 REFERENCES

A. Abbreviations and Acronyms:
   1. GMF: Glass Mat Faced.

B. Definitions:
   1. Manufacturer: Means the backing board manufacturer, unless otherwise indicated.

1.3 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data: Submit manufacturer's product data, specifications, typical installation details, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs) and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
   2. Shop Drawings: Include project-specific dimensioned details drawn to scale showing conditions not detailed on the product data; or that are detailed, but not in a manner specific to the project.

B. Informational Submittals: Submit the following for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).

1. Manufacturer's Instructions: Submit manufacturer-prepared published instructions for proper installation of furnished backing boards.
   a. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.
   b. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.
2. Qualification Statements: Submit written descriptions confirming experience specified in QUALITY ASSURANCE article below.

1.4 QUALITY ASSURANCE

A. Source Limitations:
   1. Backing boards must be obtained through one source from the same manufacturer (to ensure compatibility, regulatory conformance, and a warrantable installation).
      a. Certain items may be obtained from more than one manufacturer, but only when used for separate installations.
      b. Items provided for each different installation must be obtained from the same source and manufacturer.
   2. Backing board must be manufactured in North America by a domestic company from gypsum mined in North America; synthetic gypsum recovered from coal-fired plants operating in North America (FGD gypsum); or a combination of both.
      a. Backing board manufactured outside of North America by a domestic company are prohibited.
      b. Backing board manufactured outside of North America by a foreign company and relabeled or rebranded by a domestic company are prohibited.
   3. Provide secondary materials, components, accessories and other items from sources required, recommended, or accepted by the primary manufacturer for actual in-service conditions applicable to the project.

1.5 HANDLING

A. General: Comply with GA publication GA 801 "*Handling Gypsum Board*" and applicable requirements of ASTM C 1264 for the inspection, rejection, certification, packaging, marking, shipping, handling, and storage of gypsum panel products.

B. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
   1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
   2. Unload and store only inspected and accepted items.

C. Storage: Store unloaded items as shipped, indoors within dry, well-ventilated, broom-cleaned, and partially- or permanently-enclosed storage areas.

1. Store items indoors within dry, well-ventilated, broom-cleaned, and partially- or permanently-enclosed storage areas; where “wet work” within storage areas (e.g., concrete, cast underlayment, mortaring, grouting, plastering, gypsum board finishing, etc.) is complete and cured or dried to a condition of equilibrium.
2. Prevent stored items from contacting the floor or ground, from soiling and staining, and from deterioration and damage.

D. Handling: Handle items in conformance with manufacturer’s instructions and other requirements and recommendations, and in a manner that that prevents damage.

E. Damaged Item Replacement: Promptly remove and replace items that are deteriorated, damaged, or defective with undamaged new items that do not exhibit deterioration, damage, or defects.

F. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer: Provide products manufactured by one of the following, or equal.
1. CertainTeed Corp.
2. GP Building Products.
3. National Gypsum Co.
4. USG Corp.

2.2 GMF GYPSUM BACKING BOARD

A. Description: Gypsum-based GMF water-resistant gypsum backing panel conforming to ASTM C 1178 installed as a base for the application of ceramic tile.

B. Applications: Installed as a base for the application of ceramic tile and behind fiberglass bathtub surround walls.

C. Restrictions: May not be used
1. as a base for nailing or mechanical fastening;
2. as a radiant barrier behind fireplaces;
3. in exterior applications; and
4. In direct contact with concrete or concrete masonry units.

D. Products: Provide one of the following, or equal.
1. “DensShield Tile Backer” manufactured by GP Building Products.
2. “GlasRoc Tile Backer” manufactured by CertainTeed Corp.

3. "Gold Bond eXP Tile Backer" manufactured by National Gypsum Co.

E. Requisite Properties:
1. Minimum Size: At least 4-foot by 8-foot sheets.
2. Minimum Thickness: 1/2-inch regular core panels and 5/8-inch Type X panels.
3. Minimum Mass: At least 2.2 pounds per square foot.
4. Edges: Tapered long edges and square ends.
5. Facers: Heat-cured, acrylic-coated, fiberglass mat wrapped around panel face, back side, and long edges. Water repellent paper facers and backings are prohibited.

F. Performance Requirements:
1. Resistance to the Propagation of Mold and Mildew: Minimum score of 10 (no visual defacement), when tested in conformance with ASTM D 3273.

2.3 INSTALLATION MATERIALS

A. Fasteners: Provide 0.164-inch shank diameter (#8-32 UNC) by at least 1-1/4-inch-long Philips drive socket, bugle or wafer head, self-drilling stainless steel, bi-metal, duplex anti-corrosive steel, 3-coat anti-corrosive steel, or ceramic-coated anti-corrosive steel screw fasteners, unless another fastener type is explicitly indicated; or is otherwise supplied, required, recommended, or accepted by the manufacturer.

2.4 JOINT TREATMENT MATERIALS

A. Glass Mesh Tape:
1. Description: 2-inch wide, alkali-resistant, polymer-coated, 10x10 glass-fiber mesh tape.
2. Application: Used in combination with joint sealant as a panel joint and penetration treatment for long-term joint protection.
3. Product: Supplied, required, recommended, or accepted by the manufacturer.

B. Polymer-Modified Cementitious Mortar:
1. Description: Premium-grade (best quality grade), single-component, ultra-high-performance, polymer-modified Portland cement mortar conforming to A118.15 shear bond strength requirements.
2. Application: Used for embedding joint tape and finishing backing board in wet locations (e.g., toilet rooms, shower rooms, saunas, steam rooms, kitchens, swimming pool enclosures, etc.). Do not use drying-type joint compound, setting-type joint compound, or paper tape in wet locations.
3. Products: Provide one of the following, or equal.
a. "MegaFlex Crack Prevention Mortar" manufactured by Custom Building Products.
b. "254 Platinum" manufactured by LATICRETE International, Inc.
c. "Ultraflex 3" manufactured by Mapei Corp.

C. Setting-Type Joint Compound:
   1. Description: Lightweight, sandable, chemically setting powder compound conforming to ASTM C 475 and
   2. Application: Used for embedding joint tape and finishing backing board in locations other than wet locations. All-purpose and drying type joint compounds are prohibited.
   3. Product: "ToughRock Sandable Setting Compound" manufactured by GP Building Products, or equal.

2.5 ACCESSORIES

A. Sealant: Provide fluid-applied low modulus joint sealant specified in Section 07 92 10, unless another type of sealant; or supplied, required, recommended, or accepted by the manufacturer to seal sheathing joints and fastener penetrations.

B. Other Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification: Verify in-place supporting and adjacent construction conforms to the manufacturer's requirements or recommendations and satisfies all other conditions that might affect the quality of installation or the durability, appearance, or performance of installed and adjacent items.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.
   2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 INSTALLATION

A. General Requirements:

1. Install backing boards using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
2. Set items true to line, to required levels and lines, and plumb, level, and square, without warp or rack, with flush well-fitted joints, and in alignment with adjacent construction
3. Installed backing boards must be warrantable. Do not install, correct, or replace backing boards in a manner that results in any warranty or guarantee becoming void.

B. Interface with Adjacent Items:
1. Provide materials, components, and accessories normally furnished or necessary to securely attach backing boards to supporting construction.
2. Do not install vapor retarders directly behind backing board.

C. Installation Tolerances: Install backing boards to an allowable tolerance variation of not more than 1/4-inch from true position and not more than 1/8-inch from plumb, level, and alignment.

3.3 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
1. written descriptions of non-conforming, damaged, and defective work;
2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.4 CLEANING

A. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

END OF SECTION

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SECTION 09 29 00 – GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Gypsum board panels.
   2. Metal trim.
   3. Installation materials.
   4. Joint treatment materials.
   5. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

B. Related Requirements:
   1. Section 09 28 15 for GMF gypsum tile backing board.

1.2 REFERENCES

A. Abbreviations and Acronyms:
   1. GMF: Glass Mat Faced.

B. Definitions:
   1. Manufacturer: Means the gypsum board manufacturer, unless otherwise indicated.
   2. Enclosure: Means a level of protective resistance to weather provided for interior spaces during the construction phase by either permanent construction or substantial temporary construction. Other terms, including “enclosed” and similar terms, have the same meaning as “enclosure”.
      a. Uncontrolled Enclosure: Means short-term, limited, temporary protection against wind for up to 6 months before completion of the permanent enclosure, as determined by the Architect, whose decision is final.
      b. Partially-Controlled Enclosure: Means medium-term, limited, temporary protection against both wind and rain for up to 12 months before completion of the permanent enclosure, as determined by the Architect, whose decision is final.
      c. Permanent Enclosure: Means complete permanent protection against wind, temperature, humidity, atmospheric pressure, and precipitation; provided by a permanent insulated and weathertight roofing system, permanent insulated and weathertight exterior wall construction, and openings closed with permanent protectives or substantial temporary closures equivalent in protection to permanent protectives, as determined by the Architect, whose decision is final.

3. Dry-In: Means that the building shell is sufficiently complete to keep out wind, rain, and other weather. Other terms, including "box-in" and similar terms, have the same meaning as "dry-in". At a minimum, dry-in includes
   a. all exterior walls are constructed with weather-resistive barrier or air barrier applied;
   b. roof deck is installed with an appropriate waterproof covering; and
   c. windows and doors are installed.
4. Locations:
   a. Wet Locations: Means interior locations subject to moisture during normal activities for which the space was designed (e.g., toilet rooms, shower rooms, saunas, steam rooms, kitchens, swimming pool enclosures, etc.)
   b. Dry Locations: Means normally-dry interiors.
5. Pre-Rock Construction: Means installation in locations exposed to ambient moisture during the normal construction cycle before the structure is either partially controlled or permanently enclosed. Pre-rock construction is not limited to top-down construction. Other terms, including "pre-dry-in" and similar terms, have the same meaning as "pre-rock".
6. Top-Down Construction: Means the limited installation of gypsum board panels only in plenums above the finished ceiling plane after the installation of metal framing is complete and before the installation of ducts, conduits, pipes, or other items that penetrate the gypsum board assemblies begins.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate locations of control joints to ensure the recommended spacings of control joints for gypsum wall and ceiling panels are accommodated.
      a. If control joints are not indicated on the construction drawings, do not anticipate the quantity is zero.
      b. Propose locations on shop drawings or submit an RFI to the Architect before submitting bid proposal.
   2. Final locations of control joints are subject to Architect approval.

B. Preinstallation Meeting:
   1. Hold the meeting after submittal approval and at least 10 business days before beginning installation.
   2. During the meeting, review the Contract Documents, submittals, project conditions, and installation sequence and methods, including special details and conditions that might affect installation.
   3. Discuss and finalize locations and extents of all control joints.
   4. Identify and discuss adverse or unfavorable conditions detrimental to protecting stored materials or to installation; or to the quality, durability, appearance, or performance of installed underlayment. Resolve each condition.
   5. Finalize construction schedule.

6. Record significant discussions and distribute meeting minutes. Do not begin installation until disagreements are successfully resolved to the satisfaction of all parties.

C. Sequencing: Deliver paper-faced gypsum board to the project site only after building dry-in.

1.4 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data: Submit manufacturer's product data, specifications, typical installation details, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs) and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
   2. Shop Drawings:
      a. Submit dimensioned plans and elevations drawn to scale and showing locations, sizes, and extents of all control joints. Label manufactured items by product name.
      b. Include project-specific dimensioned details drawn to scale showing conditions not detailed on the product data; or that are detailed, but not in a manner specific to the project.

B. Informational Submittals: Submit the following for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
   1. Manufacturer's Instructions: Submit manufacturer-prepared published instructions for proper installation of furnished gypsum board.
      a. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.
      b. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.
   2. Qualification Statements: Submit written descriptions confirming experience specified in QUALITY ASSURANCE article below.

1.5 QUALITY ASSURANCE

A. Source Limitations:
   1. Gypsum board must be obtained through one source from the same manufacturer (to ensure compatibility, regulatory conformance, and a warrantable installation).
      a. Certain items may be obtained from more than one manufacturer, but only when used for separate installations.

b. Items provided for each different installation must be obtained from the same source and manufacturer.

2. Gypsum board must be manufactured in North America by a domestic company from gypsum mined in North America; synthetic gypsum recovered from coal-fired plants operating in North America (FGD gypsum); or a combination of both.
   a. Gypsum board manufactured outside of North America by a domestic company are prohibited.
   b. Gypsum board manufactured outside of North America by a foreign company and relabeled or rebranded by a domestic company are prohibited.
3. Provide secondary materials, components, accessories and other items from sources required, recommended, or accepted by the primary manufacturer for actual in-service conditions applicable to the project.

B. Qualifications:
1. Installer: Company or individuals must have at least 5 years' experience installing gypsum board for at least 30 previous projects similar to this project in size, material, design, and complexity.
2. Supervisors: Individuals must have at least 7 years' experience installing gypsum board for at least 30 previous projects similar to this project in size, material, design, and complexity, including at least 2 years' supervisory experience directing and leading gypsum board installers.

1.6 HANDLING

A. General: Comply with GA publication GA 801, "*Handling Gypsum Board*" and applicable requirements of ASTM C 1264 for the inspection, rejection, certification, packaging, marking, shipping, handling, and storage of gypsum panel products.

B. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
2. Reject items that are not transported, delivered, or protected in conformance with manufacturer-recommended transport, delivery, and receiving requirements.
3. Unload and store only inspected and accepted items.

C. Storage: Store unloaded items indoors as shipped, upright in their original packaging or containers, within dry, well-ventilated, broom-cleaned and enclosed storage areas.
1. Furnish adequate dunnage and bracing during storage.
2. Prevent stored items from contacting the floor, from soiling and staining, and from deterioration and damage.
3. Do not leave items uncovered where they might be exposed to weather or become wet; or exposed to heat or sudden changes in temperature or relative humidity; or other sources of deterioration and damage, including dust and other airborne contaminants.

D. Handling: Handle items in conformance with manufacturer's instructions and other requirements and recommendations, and in a manner that that prevents damage. Avoid damage to packaging and containers.

E. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective gypsum board with undamaged new gypsum board that does not exhibit deterioration, damage, or defects.

F. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer: Provide products manufactured by one of the following, or equal.
   1. CertainTeed Corp.
   2. GP Building Products.
   3. National Gypsum Co.
   4. USG Corp.

2.2 PRE-ROCK GYPSUM BOARD

A. Description: GMF interior gypsum panels conforming to ASTM C 1658.

B. Application: Pre-rock panels must be used when gypsum board is installed prior to dry-in.

C. Products: Provide one of the following, or equal.
   1. "DensArmor Plus Interior Panels" manufactured by GP Building Products.
   2. "e^{2}XP Interior Extreme" manufactured by National Gypsum Co.
   3. "SHEETROCK Glass-Mat Panels Mold Tough" manufactured by USG Corp.

D. Requisite Properties:
   1. Minimum Size: Provide at least 4-foot by 8-foot sheets.
   2. Minimum Thickness: 1/2-inch regular core panels and 5/8-inch Type X panels.
   3. Edges: Tapered long edges and square ends.
   4. Facers: Heat-cured, acrylic-coated, fiberglass mat on the face side, back side, and around long edges. Water repellent paper facers and backings are prohibited.

2.3 FIRE-RESISTANCE RATED GYPSUM BOARD

A. Fire-Resistance-Rated Gypsum Wall and Ceiling Board:

1. Description: Gypsum board conforming to ASTM C 1396.
2. Applications: Installed in fire-resistance-rated and non-rated interior partition assemblies constructed in dry locations.
3. Products: Provide one of the following, or equal.
   a. "ProRoc Type X" and "ProRoc Type C" manufactured by CertainTeed Corp.
   b. "ToughRock Fireguard" and "ToughRock Fireguard C" manufactured by GP Building Products.
   c. "Gold Bond Fire-Shield" and "Gold Bond Fire-Shield C" manufactured by National Gypsum Co.
   d. "SHEETROCK "Firecode Core"" and "SHEETROCK "Firecode C Core""
4. Requisite Properties:
   a. Minimum Size: At least 4-foot by 8-foot sheets.
   b. Minimum Thickness: At least 5/8-inch.
   c. Core: Provide Type X panels in walls and Type C panels in ceilings, unless otherwise indicated on the Drawings.
   d. Minimum Mass: At least 2.2 pounds per square foot.
   e. Edges: Tapered long edges and square ends.
   f. Facers: Paper face, back, and long edges.

B. Mold- and Moisture-Resistant Fire-Resistance-Rated Gypsum Wall and Ceiling Board:
1. Description: Mold- and moisture-resistant and fire-resistance-rated gypsum board conforming to ASTM C 1396.
2. Applications: Installed as the inside face of exterior wall assemblies; and in fire-resistance-rated and non-rated interior partition assemblies constructed in wet locations.
3. Products: Provide one of the following, or equal.
   a. "ProRoc Moisture and Mold Resistant Gypsum board with M2Tech" manufactured by CertainTeed Corp.
   b. "ToughRock Mold-Guard" manufactured by GP Building Products.
   c. "Gold Bond XP Gypsum Board" manufactured by National Gypsum Co.
   d. "SHEETROCK Mold Tough" manufactured by USG Corp.
4. Requisite Properties:
   a. Minimum Size: At least 4-foot by 8-foot sheets.
   b. Minimum Thickness: At least 5/8-inch.
   c. Core: Provide Type X panels in walls and Type C panels in ceilings, unless otherwise indicated on the Drawings.
   d. Minimum Mass: At least 2.2 pounds per square foot.
   e. Edges: Tapered long edges and square ends.
   f. Facers: Heavy-duty mold- and moisture-resistant paper face, back, and long edges.
5. Performance Requirements:

a. Mold Resistance: Must earn a score of at least 10, when tested in conformance with ASTM D 3273.

2.4 METAL TRIM

A. Steel Trim:
   1. Description: Paper-faced galvanized steel sheet trim pieces conforming to ASTM C 1047.
   2. Manufacturers: Provide products manufactured by one of the following, or equal.
      a. CEMCO.
      b. Clinch-On Cornerbead Co.
      c. Stockton Products.
      d. Western Metal Lath.
      e. USG Corp.
   3. Products: “BEADEX” paper-faced metal bead and trim manufactured by USG Corp., or equal.
      a. Corner Beads: Provide to protect exterior corners. Provide corner beads with notched or flexible flanges at curved edges.
         1) 90-degree Outside Corner Bead: “Micro Bead Style”, or equal.
         2) 90-degree Inside Corner Bead: “B2 Style”, or equal.
      b. Casing Beads: Provide long-flanged L- or LC-beads at exposed panel edges indicated as receiving joint compound; provide short-flanged U-beads at exposed panel edges that do not receive joint compound.
         1) J Trims (J-shaped with exposed long flange): “B9J Style”, or equal.
         2) L Trims (L-shaped with exposed long flange): “B4 Style”, or equal.

B. Metal Control Joints:
   1. Description: One-piece solid zinc control joint supplied with factory-applied removable tape to ensure a clean joint.
   2. Products: Provide one of the following, or equal.
      a. “NO93 Control Joint” manufactured by Alabama Metal Industries Corp. Building Products (AMICO).
      b. “Niles-093 Zinc Control Joint” manufactured by Niles Building Products Co.
      c. “SHEETROCK Zinc Control Joint No. 093” manufactured by USG Corp.
   3. Requisite Properties:
      a. Minimum Length: At least 10 feet long; provide longest possible lengths to minimize or avoid joints.

2.5 INSTALLATION MATERIALS

A. Fasteners: Provide #6-32 UNC 2B (0.138-inch shank diameter, 32 threads per inch) by at least 1-1/4-inch long, Philips bugle head, coarse thread, self- piercing or self-drilling (as applicable) phosphate coated steel screw fasteners, unless another fastener type is

explicitly indicated; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

B. Laminating Adhesive:
   1. Description: Lightweight, sandable, chemically-setting powder compound conforming to ASTM C 475.
   2. Application: Used for bonding gypsum board to studs, laminating gypsum board to gypsum board, and bonding gypsum board to concrete or CMU walls.
   3. Product: “SHEETROCK Easy Sand Joint Compound” manufactured by USG Corp., or equal.

2.6 JOINT TREATMENT MATERIALS

A. Joint Tape:
   1. Description: Nominal 2-inch wide gypsum panel joint and corner reinforcement conforming to ASTM C 475.
   2. Products:
      a. Fiberglass Joint Tape: “SHEETROCK Fiberglass Drywall Tape” manufactured by USG Corp., or equal.
      b. Paper Joint Tape: “BEADEX Drywall Joint Tape” manufactured by USG Corp., or equal.
      c. Fiberglass Mesh Tape: Prohibited.

B. Setting-Type Joint Compound:
   1. Description: Lightweight, sandable, chemically setting powder compound conforming to ASTM C 475, and used for embedding joint tape and finishing interior gypsum panels.
   2. Applications:
      a. Pre-Filling Gypsum Panel Joints throughout the Project: Use setting-type compound for open joints, beveled panel edges, and at damaged surface areas at all locations.
      b. All Other Coats: Use setting-type compound for embedding and first coat, fill coat, finish coat, and skim coat at wet locations; and at locations where panels are subject to moisture and high humidity.
   3. Product: “SHEETROCK DURABOND” manufactured by USG Corp., or equal.

C. Drying-Type Joint Compound:
   1. Description: Vinyl-type compound conforming to ASTM C 475, and used for embedding joint tape, finishing interior gypsum panels, and hand-applying simple texturing.
   2. Application: Use for embedding and first coat, fill coat, finish coat, and skim coat at dry locations, and at locations where joint is subject to moisture and high humidity.

3. Product: “SHEETROCK All Purpose Joint Compound – SELECT” and “SHEETROCK Brand Plus 3 Lightweight All-Purpose Joint Compound” manufactured by USG Corp., or equal.

2.7 ACCESSORIES

A. Texture Finish:
   1. Description: Unaggregated texture coating wall and ceiling texture.
   2. Restrictions: New concrete and new plaster must age at least 60 days before texturing.
   3. Concrete Crack Repair and Surface Preparation: Setting-type compound specified above.
   4. Primer: “SHEETROCK FIRST COAT Primer” manufactured by USG Corp., or equal.
   5. Texture Product: “SHEETROCK TUF-TEX” manufactured by USG Corp., or equal.
   6. Finish: Fine orange peel.

B. Applied Level 5 Wallboard Finish Products: Prohibited.

C. Repair Clips: “SHEETROCK Drywall Repair Clips” manufactured by USG Corp., or equal.

D. Other Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

2.8 MARKING AND IDENTIFICATION

A. Description: Fire walls, fire barriers, fire partitions, smoke barriers and smoke partitions, and other walls required by the California Building Code to have protected openings or penetrations must be effectively and permanently identified with stenciling located in accessible concealed floors, floor-ceiling assemblies, plenums, and attic spaces

B. Paint Products: Specified in Section 09 91 00.

C. Fire Walls, Fire Barriers, and Fire Partitions: Paint 6-inch high stripes not more than 15 feet from the end of each fire wall, fire barrier, or fire partition; and at intervals of not more than 30 feet, when measured horizontally along the wall, barrier, or partition. Paint stenciled letters over the 6-inch high stripes, leaving at least a one-inch border around the stenciled letter copy.
   1. Stripe Color: Match Federal Standard 595B color FS 31350 (red).
   2. Stenciled Letter Color: Match Federal Standard 595B color FS 37925 (insignia white).
   3. Stenciled Letter Font: 288-Point Linotype Neue Helvetica Regular Bold.
   4. Stenciled Letter Copy:
      a. Fire Walls: “FIRE WALL – PROTECT ALL OPENINGS”.
      b. Fire Barriers: “FIRE BARRIER – PROTECT ALL OPENINGS”.

c. Fire Partitions: “FIRE PARTITIONS – PROTECT ALL OPENINGS”.

D. Smoke Barriers and Smoke Partitions: Paint 6-inch high stripes not more than 15 feet from the end of each smoke barrier or smoke partition; and at intervals of not more than 30 feet, when measured horizontally along the wall, barrier, or partition. Paint stenciled letters over the 6-inch high stripes, leaving at least a one-inch border around the stenciled letter copy.
   1. Stripe Color: Match Federal Standard 595B color FS 36492 (gray).
   2. Stenciled Letter Color: Match Federal Standard 595B color FS 37038 (black).
   3. Stenciled Letter Font: 288-Point Linotype Neue Helvetica Regular Bold.
   4. Stenciled Letter Copy:
      a. Smoke Barriers: “SMOKE BARRIER – PROTECT ALL OPENINGS”.
      b. Smoke Partitions: “SMOKE PARTITIONS – PROTECT ALL OPENINGS”.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification: Verify in-place supporting and adjacent construction conforms to the manufacturer’s requirements or recommendations and satisfies all other conditions that might affect the quality of installation or the durability, appearance, or performance of installed and adjacent items.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the manufacturer’s instructions and other requirements and recommendations.
   2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 INSTALLATION

A. General Requirements:
   1. Install gypsum board using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
   2. Set items true to line, to required levels and lines, and plumb, level, and square, without warp or rack, with flush well-fitted joints, and in alignment with adjacent construction

3. Installed gypsum board must be warrantable. Do not install, correct, or replace gypsum board in a manner that results in any warranty or guarantee becoming void.

B. Special Techniques:
   1. Single-Layer Application:
      a. On ceilings, apply gypsum panels before wall or partition board application to greatest extent possible, and at right angles to framing, unless otherwise indicated.
      b. On partitions and walls, apply gypsum panels vertically (parallel to framing), unless otherwise indicated or required by fire-resistance-rated assemblies; minimize end joints.
      c. At stairwells and other high walls, install panels horizontally, unless otherwise indicated or required by fire-resistance-rated assemblies.
      d. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
      e. Stagger abutting end joints not less than one framing member in alternate courses of panels.
      f. Securely attach gypsum panels to supports with steel drill screws.
   2. Multilayer Application:
      a. On partitions and wall assemblies, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
      b. On Z-furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
      c. Securely attach base layers and face layers separately to supports with screws. Do not glue multiple layers of gypsum board together.
   3. Trim:
      a. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim in conformance with manufacturer's instructions.
      b. Control Joints: Install control joints in conformance with ASTM C 840 and in specific locations indicated or accepted by the Architect.
      C. Trim: Install cornerbead at outside corners; install LC-Bead or U-Bead at exposed panel edges.
   4. Finishing Gypsum Board:
      a. Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and other items and conditions as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
      b. Prefill open joints, beveled edges, and damaged surface areas.

c. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.

C. Acoustical Installation Requirements:
1. Comply with ASTM C 840.
2. Install panels with face side out. Butt panels together with light contact at edges and ends and not more than 1/16-inch of open space between panels. Do not force into place.
3. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided.
4. Comply with ASTM C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
5. All joints must be staggered at least 24 inches apart and taped and sealed. Where multi-layer construction is indicated, each layer must be complete, including tape, fillers, and seals, before further layers are added
6. Joints between uncut sheet that lie in the same plane must be tight butt joints. The gap between sheets may not exceed 1/8-inch.
7. Tolerances: Install partitions with the following maximum gaps between gypsum board and abutting construction.
   a. Floor: 1/4-inch.
   b. Masonry and Concrete Walls: 1/4-inch.
   c. Underside of Slab or Decking: 1/4-inch.
8. Damaged sheets may not be used. Joints between cut sheets that lie in the same plane or between any sheets that lie in different planes (i.e., at any angle or corner joint) must be cut back to produce a neat gap not more than 1/16-inch wide and the joint filled and sealed with specified non-hardening acoustic sealant. Subsequent layers must cover the joint and the opposite sheet must be cut short and filled and sealed.
9. In the first layer, all joints between boards must be backed by a continuous stud, noggin, bearer, or angle.
10. Specified batt insulation must be placed in the wall cavity and be suitably retained so that it is in contact with only one face of the partition and does not sag.
11. Wall ties between adjacent independent partitions must be of a resilient type and accepted by the Architect. The minimum number compatible with safe construction should be used.
12. The walls must be constructed from slab to slab (full height) unless otherwise indicated.
13. Where door frames are built into the wall, the vertical and horizontal sections of the frame shall be fully filled with plaster. The plaster joint shall be to the full depth of the wall.
14. Top and bottom of stud walls must be Isolated with resilient partition isolation pad (e.g., “Wallmat and Anchor Isolator” manufactured by Kinetics Noise Control, Inc., or eqal)

15. Lateral support at the head of vibration isolated gypsum walls must be a continuous steel angle with a resilient pad to avoid rigid contact between the wall and the lateral support construction and accepted by the Architect. (e.g., wall mount type AB by Mason Industries, or equal)
16. All joints between gypsum and other constructions must be dense packed with fiberglass to the full depth of the wall and fully sealed with a sealant bonding to the gypsum and the other construction.
17. Where gypsum walls abut a profiled metal decking, the gypsum wall should seal to a minimum 16 -gage steel plate attached to the deck, with the profile void above the plate filled with fiberglass and acoustically sealed on both sides with a fire barrier putty having a minimum density of 40 pounds per square foot. (e.g., 3M Moldable Putty or equal)
18. For top of walls that are perpendicular with the metal decking maximum of ½ inch gap from the flute and seal the openings with acoustical sealant.
19. Penetrations of building services (e.g., ducts, conduits, pipes) through full height and acoustic rated partitions must be sealed airtight in conformance with the following.
    a. Seal all annular openings less than 1/2-inch with acoustical sealant and backer rod as required to hold sealant in place.
    b. When the annular opening is larger than 1/2-inch, provide gypsum board patch to reduce the opening to less than 1/2-inch, and seal as above.
    c. Prior to sealing penetrations, verify penetrating elements such as piping and ductwork are free and clear of the opening being sealed.
20. Cut-outs must be regular and may not fracture gypsum board core or tear covering and must conform to the following.
    a. Minimize penetrations of insulated wall and ceiling construction. Penetrate only where necessary and fully seal airtight at the perimeter using acoustical sealant.
    b. Where ducts and piping greater than 3-inches in diameter penetrate insulated wall or ceiling construction, provide a clearance of one-inch plus 1/4-inch at the perimeter of the penetration
    c. Where conduit piping 3-inches diameter and less (including mechanical, hydraulic, plumbing, etc.) pass through insulated wall or ceiling construction, provide a clearance of 1/4-inch plus 1/8-inch between the conduit or piping and the structure, unless otherwise shown.
    d. After the ductwork, conduit, or piping is installed, repair the gypsum board perimeter clearance to the specified tolerance as required. Where the clearance exceeds 3/4-inch, provide a sheet metal sleeve within the partition packed with safing insulation and seal both sides airtight with acoustical sealant.
    e. Where penetration clearances are 3/8-inch or less, seal airtight with acoustical sealant at gypsum board. Where the perimeter clearance exceeds 3/8-inch, use a flexible backing rod to seal against.
    f. All gypsum board penetrations (including those resulting from wiring, cables, and electrical junction boxes) must be sealed airtight with acoustical sealant.
    g. The back and sides of junction boxes in sound-rated construction must be sealed airtight with sheet caulking. Seal perimeter face at gypsum board with acoustical sealant.

h. Recessed panel boards, equipment, boxes, and other items having a penetration area greater than 25 square inches at sound-rated partitions are fully enclosed and sealed with 5/8-inch thick gypsum board or 2 pound per square foot sheet metal.
i. Seal multiple conduit penetrations airtight with expanding fire foam sealant.

D. Interface with Adjacent Items:
1. Provide materials, components, and accessories normally furnished or necessary to securely attach gypsum board to supporting construction.
2. Do not install vapor retarders directly behind gypsum board.

E. Installation Tolerances: Install gypsum board to an allowable tolerance variation of not more than 1/4-inch from true position and not more than 1/8-inch from plumb, level, and alignment.

3.3 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
1. written descriptions of non-conforming, damaged, and defective work;
2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.4 CLEANING

A. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

3.5 PROTECTION

A. Protect installed gypsum board in place from deterioration, and damage until Substantial Completion. Remove and replace wet, moisture-, or mold-damaged panels.
1. Indications panels are wet or moisture damaged include discoloration, sagging, or irregular shape.

2. Indications that panels are mold damaged include fuzzy or splotchy surface contamination and discoloration.

B. Do not store anything adjacent to or against installed gypsum board unless it is protected from damage, as accepted in writing by the manufacturer's representative. Do not use installed gypsum board as work surfaces.

C. Remove protection when it's no longer needed and before Substantial Completion.

3.6 GYPSUM BOARD FINISH SCHEDULE

A. General: Finish gypsum board surfaces with exposed joints, corners and edges reinforced or trimmed in conformance with ASTM C 840, Gypsum Association publication GA-214, "*Recommended Levels of Gypsum Board Finish*", and the following.

B. Levels of Gypsum Board Finish:
1. Level 0: Use for first layer of multiple layer construction and gypsum board ledge guards in elevator shafts.
2. Level 1: Use in plenum areas above ceilings, interior faces of shafts, in attics, and in areas where the assembly will generally be concealed.
3. Level 2: Use where moisture-resistant gypsum backing board is used as a substrate for tile; and in storage and similar areas where surface appearance is not of primary concern.
4. Level 3: Use in areas where heavy grade wall coverings are to be applied as the final decoration.
5. Level 4: Use in areas where light texture or backed lightweight wall covering is applied; and all areas indicated as receiving a paint finish, except where Level 5 finish is indicated.
6. Level 5 (spray and roller-applied products are prohibited): Use where indicated on the Drawings.

END OF SECTION

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SECTION 09 51 13 – ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Suspended acoustical ceiling panels.
   2. Suspension system.
   3. Installation materials.
   4. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

1.2 REFERENCES

A. Abbreviations and Acronyms:
   1. CISCA: Ceilings & Interior Systems Construction Association.
   2. ASW: American Steel and Wire Co.
   3. SWG: Steel Wire Gauge.

B. Definitions:
   1. Manufacturer: Means the acoustical ceiling manufacturer, unless otherwise indicated.
   2. Ceiling: Means the ceiling finish and associated suspension systems.
   3. Wire Gage (Steel Wire Gage): Means the diameter of steel wire, in inches, according to dimensions established by Washburn & Moen, Roebling, or American Steel and Wire Co.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate ceiling layout and installation with adjacent construction elements that penetrate ceilings, or is supported by them, including
   1. light fixtures;
   2. HVAC equipment;
   3. fire-suppression system components;
   4. partition assemblies; and
   5. perimeter conditions.

B. Sequencing:

1. Schedule acoustical ceiling deliveries to the project site only after the building is enclosed with a permanent enclosure; “wet work” within storage areas (including concrete, cast underlayment, mortaring, grouting, plastering, and gypsum board finishing) is complete and cured or dried to a condition of equilibrium; and storage areas are broom- and vacuum-clean.
2. Before beginning installation, final light fixtures must be completely installed, energized, and fully illuminated to at least the same type and level of illumination, and color temperature, maintained in the room or space after the building is occupied.
3. Install acoustical ceilings only after penetrating items are installed.
4. After acoustical ceiling installation, maintain ambient conditions within a range required, recommended, approved, or accepted by the manufacturer until Final Completion.

C. Scheduling: Allow sufficient time in the construction schedule to acclimate acoustical ceilings to specified ambient conditions for at least 48 hours before installation begins.

1.4 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data:
      a. Submit manufacturer’s product data, specifications, typical installation details, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs) and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
   2. Shop Drawings:
      a. Submit dimensioned plans drawn to scale and showing acoustical ceiling layout, materials, joints, edge conditions, and finishes. Show locations, sizes, and extents of all items, accessories, and trim. Label manufactured items by product name.
      b. Include project-specific dimensioned details drawn to scale showing conditions not detailed on the product data; or that are detailed, but not in a manner specific to the project. Cross-reference details to plans.
   3. Samples:
      a. Submit at least 8-inch square representative samples of each acoustical ceiling variety for each specified color and finish.
      b. Submit at least 8-inch long representative samples of each suspension system exposed tee, molding, and trim variety in each specified color and finish.

B. Informational Submittals: Submit the following for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).

1. Coordination Drawings: Submit at least 1/4-inch scale dimensioned reflected ceiling plans showing the following items coordinated with each other, based on input from installers of each item involved.
   a. Ceiling suspension system members.
   b. Method of attaching hangers to building structure. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.
   c. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
2. Manufacturer's Instructions: Submit manufacturer-prepared published instructions for proper installation of furnished acoustical ceilings.
   a. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.
   b. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.
3. Qualification Statements: Submit written descriptions confirming experience specified in QUALITY ASSURANCE article below.

C. Maintenance Material Submittals:
1. Before Final Completion, deliver to the Owner acoustical ceiling cleaning materials, equipment, accessories, and instructions; and extra stock materials to replace those worn or damaged as a result of normal occupancy.
2. Furnish at least 2 percent of the total installed for each acoustical ceiling type, color, composition, grade, finish, and variety, but not less than one box or open container.

1.5 QUALITY ASSURANCE

A. Source Limitations:
1. Acoustical ceilings must be obtained through one source from the same manufacturer (to ensure compatibility, regulatory conformance, and a warrantable installation).
   a. Certain items may be obtained from more than one manufacturer, but only when used for separate installations.
   b. Items provided for each different installation must be obtained from the same source and manufacturer.
2. Provide secondary materials, components, accessories and other items from sources required, recommended, or accepted by the primary manufacturer for actual in-service conditions applicable to the project.

B. Regulatory Requirements:
1. Surface-Burning Characteristics: Provide acoustical ceilings having a maximum FSI Value of 25 or less and a maximum SDI Value of less than 450 (Class A), when tested in conformance with ASTM E 84.

2. Ceiling panels, other than acoustical panels, weighing more than 1/2-pound per square foot must be positively attached to ceiling suspension runners in conformance with California Building Code Section1616A.1.21.

C. Quality Standards
1. Seismic Standard: Provide acoustical ceilings designed and installed to withstand the effects of earthquake motions in conformance with ASCE/SEI 7, "*Minimum Design Loads For Buildings and Other Structures*"; CISCA publication, "*Seismic Construction Handbook*"; and California Building Code Sections 803.9.1.1, 1614, 1616A.1.20, and 2506.2.1.
2. Installation Standard: Comply with CISCA publication "*Ceiling Systems Handbook*" requirements for installation.

D. Qualifications:
1. Installer: Company or individuals must have at least 5 years' experience installing acoustical ceilings for at least 30 previous projects similar to this project in size, material, design, and complexity.
2. Supervisors: Individuals must have at least 7 years' experience installing acoustical ceilings for at least 30 previous projects similar to this project in size, material, design, and complexity, including at least 2 years' supervisory experience directing and leading acoustical ceiling installers.

1.6 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
2. Reject items that are not transported, delivered, or protected in conformance with manufacturer-recommended transport, delivery, and receiving requirements.
3. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items indoors as shipped, upright in their original packaging or containers, within dry, well-ventilated, broom-cleaned and enclosed storage areas.
1. Furnish adequate dunnage and bracing during storage.
2. Prevent stored items from contacting the floor, from soiling and staining, and from deterioration and damage.
3. Do not leave items uncovered where they might be exposed to weather or become wet; or exposed to heat or sudden changes in temperature or relative humidity; or other sources of deterioration and damage, including dust and other airborne contaminants.

C. Handling: Handle items in conformance with manufacturer's instructions and other requirements and recommendations, and in a manner that that prevents damage. Avoid damage to packaging and containers.

D. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective ceiling materials with undamaged new ceiling materials that do not exhibit deterioration, damage, or defects.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

1.7 PROJECT CONDITIONS

A. Ambient Conditions: Install acoustical ceilings only when ambient temperature, RH, and other environmental conditions fall within ranges required, recommended, or accepted by the manufacturer.

B. Existing Conditions: Provide permanent lighting or illuminate work spaces to at least the same level occurring in the room or space after Final Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide products manufactured by one of the following, or equal.
   1. Armstrong World Industries.
   2. CertainTeed Corp.
   3. USG Interiors, Inc.

2.2 ACOUSTICAL CEILING PANELS

A. Product: Indicated on the Drawings in the Finish Schedule Sheet IE601, or equal.

B. Performance Requirements:
   1. Minimum Noise Reduction Coefficient (NRC): At least NRC 0.80, when tested in conformance with ASTM E 492 and ASTM E 989.
   2. Minimum Ceiling Attenuation Class (CAC): At least CAC 35, when tested in conformance with ASTM E 492 and ASTM E 1414.
   3. Minimum Light Reflectance (LR): Provide LR value of at least 0.87, when tested in conformance with ASTM E 1477.

2.3 SUSPENSION SYSTEMS

A. Description: Non-rated direct hung ceiling suspension system conforming to ASTM C 635 requirements for Heavy Duty structural classification.

B. Product: “Prelude XL” manufactured by Armstrong World Industries, or equal.

C. Requisite Properties:
   1. Size: 15/16-inch bottom flange face dimension by 1-11/16-inch web height.
   2. Profile Type: Exposed tee.
   3. Material: Hot dip galvanized steel sheet.
   4. Finish: Manufacturer's standard shop-applied pre-treatment and baked enamel finish.
   5. Color: Match Armstrong color WH, "White".

2.4 INSTALLATION MATERIALS

A. Attachment Devices: Sized for 5 times the design load indicated in ASTM C 635 Table 1, Direct Hung, unless otherwise indicated. Comply with seismic design requirements.

B. Wire: Soft temper, zinc-coated, pre-stretched, galvanized carbon steel wire conforming to ASTM A 641 Class 3 or A coating and having a minimum yield-stress load of 3 times the design load.
   1. Hanger Wire: Minimum 0.106-inch diameter. (ASW12)
   2. Diagonal Bracing Wire: Minimum 0.106-inch diameter. (ASW12)
   3. Provide heavier gage hanger wire for ceiling systems heavier than 4 pounds per square foot.

C. Compression Struts: Provide one of the following.
   1. Cold or hot rolled angles, loadbearing or non-loadbearing studs, EMT or rigid conduit, or black iron.
   2. Cold-rolled steel section with maximum L/R ratio of not more than 200.

D. Engineered Compression Struts:
   1. Description: Pre-engineered telescoping seismic compression posts manufactured from heavy-wall galvanized tubing.
   2. Application: Manufactured compression struts may be provided in lieu of compression struts indicated above when installed in conformance with its manufacturer's instructions.
   3. Products: Provide one of the following, or equal.
      a. "ARMSTRONG 5594 Ceiling Tile Compression Strut" manufactured by Armstrong World Industries, or equal.
      b. "Donn Brand Compression Post VSA" manufactured by USG Interiors, Inc. (ICC ES Report No. ESR-1222), or equal.

E. Fastenings: Provide backings, inserts, loose connection hardware, fasteners, anchors, attachments, connectors, and other items supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

2.5 ACCESSORIES

A. Seismic Clips:
   1. Description: 2-inch beam end retaining clip that joins main beam or cross tee to wall molding and web of grid with no visible pop rivets.
   2. Restrictions: Use of seismic clips is permitted only when specifically detailed on the Drawings. Alternative method of construction plan-review approval is required for use of seismic clips.
   3. Products: Provide one of the following, or equal.
      a. "BERC 2" clips manufactured by Armstrong World Industries, or equal.
      b. "ACM7" clips manufactured by USG Interiors, Inc., or equal.

B. Seismic Separation Joints: Provide ceiling system manufacturer's standard at seismic separation joints at ceiling locations where the contiguous area of non-broken ceiling is 2,500 square feet or greater.

C. Perimeter Wall Molding: Provide the following manufactured by Armstrong World Industries, or equal, with prefinished exposed flanges matching suspension system.
   1. Angle Molding: "No. 7808", or equal, 2-inch flange by 2-inch high hemmed edge molding.
   2. Shadow Molding: "No. 7823", or equal, 2-inch flange by 1-1/4-inch high by 3/4-inch reveal hemmed edge molding.
   3. Shadow Molding Installed with Seismic Clips:
      a. Application: Compatible with Seismic Rx and BERC 2 clips.
      b. Product: "No. 7897" 15/16-inch flange by 15/16-inch high by 1/2-inch reveal hemmed edge molding.
   4. Channel Molding: "No. 7834", or equal, 15/16-inch flange by 1-1/4-inch high by 1/2-inch reveal hemmed edge molding.

D. Perimeter Trim: "Axiom Building Perimeter System" manufactured by Armstrong World Industries, or equal, for ACT ceiling tiles flush with adjacent gypsum board soffits.

E. Other Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification:
   1. Verify in-place supporting and adjacent construction conforms to the manufacturer's requirements or recommendations and satisfies all other conditions that might affect the quality of installation or the durability, appearance, or performance of installed and adjacent items.
   2. Verify items penetrating acoustical ceilings are installed.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.
   2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 INSTALLATION

A. General Requirements:
   1. Install acoustical ceilings using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
   2. Set items true to line, to required levels and lines, and plumb, level, and square, without warp or rack, with flush well-fitted joints, and in alignment with adjacent construction
   3. Installed acoustical ceilings must be warrantable. Do not install, correct, or replace acoustical ceilings in a manner that results in any warranty or guarantee becoming void.

B. Special Techniques:
   1. Suspend ceiling hangers from building's structural members.
      a. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, post installed mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
      b. Do not attach hangers to steel deck tabs. Do not attach hangers to steel roof deck. Attach hangers to structural members.
   2. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of the supporting structure or ceiling suspension system.
   3. Space hangers not more than 48 inches on center along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
      a. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.

b. Where width of ducts and other construction within ceiling plenums produce hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
c. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by the quality standard publications.

4. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, counter-splaying, or other equally effective means.
   a. Secure wire hangers to ceiling suspension members and to supports above with at least 3 tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Secure bracing wires to ceiling suspension members and to supports with at least 4 tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or post installed anchors.
6. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
7. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
   a. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
   b. Mechanically-fasten moldings to substrates at intervals not more than 16 inches on center and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
   c. Do not use exposed fasteners, including pop rivets, on moldings and trim.
8. Install ceiling panels with undamaged edges and fit accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
   a. Arrange directionally patterned ceiling panels as indicated on reflected ceiling plans. Install panels with pattern running in one direction parallel to short axis of space.
   b. For square-edged panels, install with edges fully hidden from view by flanges of suspension system runners and moldings.
   c. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by ceiling panel manufacturer.
   d. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

C. Interface with Adjacent Items: Provide materials, components, and accessories normally furnished or necessary to securely attach acoustical ceilings to supporting construction.

D. Installation Tolerances: Ceilings must conform to the following tolerances, which are non-cumulative.
   1. Maximum Out of Plane: Surfaces may not vary by more than 1/8-inch in 10 feet.
   2. Carrying Channel Maximum Out of Level: Not more than 1/8-inch in 12 feet,
   3. Main Runner Maximum Out of Level: Not more than 1/4-inch in 10 feet,
   4. Main Runner Maximum Deflection: Not more than L/360 of span,
   5. Maximum Misalignment of Main Runners: 0.015-inch.
   6. Maximum Misalignment of Intersection Members: 0.020-inch.
   7. Main Runner Bow, Camber, and Twist: Not more than 1/32-inch in 2 feet bow or camber; not more than one degree twist.

3.3 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
   1. written descriptions of non-conforming, damaged, and defective work;
   2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
   3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect’s acceptance.

3.4 CLEANING

A. Cleaning Work: Clean all visible surfaces in a manner that does not result any warranty or guarantee becoming void.
   1. Use cleaning materials, equipment, and accessories supplied, and means, methods, techniques, and procedures required, recommended, or accepted by the manufacturer.
   2. Do not use cleaning materials or procedures known to change, or that might change, the appearance of exposed finishes or adjacent surfaces; or cause deterioration or damage to exposed finishes or adjacent surfaces.
   3. Protect adjacent surfaces not being cleaned from staining, deterioration, damage, or other detrimental effects caused by cleaning.

4. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be cleaned to the Architect's acceptance.

B. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

3.5 PROTECTION

A. Protect installed acoustical ceilings in place from deterioration, and damage until Substantial Completion.

B. Remove protection when it's no longer needed and before Substantial Completion.

END OF SECTION

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SECTION 09 65 13 – RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Resilient wall base.
   2. Resilient floor transitions.
   3. Installation materials.
   4. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

B. Related Requirements:
   1. Section 09 29 00 for definition of “permanent enclosure”.

1.2 REFERENCES

A. Definitions:
   1. Manufacturer: Means the resilient base or accessory manufacturer, as the context admits, unless otherwise indicated.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Schedule resilient base and accessory deliveries to the project site only after the building is enclosed with a permanent enclosure; “wet work” within storage areas (including concrete, cast underlayment, mortaring, grouting, plastering, and gypsum board finishing) is complete and cured or dried to a condition of equilibrium; storage areas are broom- and vacuum-clean; and the HVAC system is activated, operating, and maintaining ambient conditions at occupancy levels.
   2. Final light fixtures must be completely installed and energized before beginning installation.
   3. Install resilient base and accessories only after all other finishing operations are complete, especially overhead finishes.
   4. After resilient base and accessory installation, maintain ambient conditions within a range required, recommended, approved, or accepted by the manufacturer until Final Completion.

B. Scheduling:

1. Acclimation: Allow sufficient time in the construction schedule to acclimate resilient base and accessories and installation materials to specified ambient conditions for at least 48 hours before installation begins.
2. Primer Installation: Resilient base and accessories must be applied within 24 hours of primer installation. Re-prime surfaces exposed for more than 24 hours; follow manufacturer's instructions for re-priming.

1.4 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data: Submit manufacturer's product data, specifications, typical installation details, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs), and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.

B. Informational Submittals: Submit the following for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
   1. Manufacturer's Instructions: Submit manufacturer-prepared published instructions for proper installation of furnished resilient base and accessories.
      a. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.
      b. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.
   2. Qualification Statements: Submit written descriptions confirming experience specified in QUALITY ASSURANCE article below.

C. Maintenance Material Submittals:
   1. Before Final Completion, deliver to the Owner resilient base and accessory cleaning materials, equipment, accessories, and instructions; and extra stock materials to replace those worn or damaged as a result of normal occupancy.
   2. Furnish at least 2 percent of the total installed for each resilient base and accessory type, color, composition, grade, finish, and variety, but not less than one unopened box or container.

1.5 QUALITY ASSURANCE

A. Source Limitations:
   1. Resilient base and accessories must be obtained through one source from the same manufacturer (to ensure compatibility, regulatory conformance, and a warrantable installation).

a. Certain items may be obtained from more than one manufacturer, but only when used for separate installations.
b. Items provided for each different installation must be obtained from the same source and manufacturer.

2. Provide secondary materials, components, accessories and other items from sources required, recommended, or accepted by the primary manufacturer for actual in-service conditions applicable to the project.

B. Regulatory Requirements:
1. Surface-Burning Characteristics: base having a maximum FSI Value of 25 or less and a maximum SDI Value of less than 450 (Class A), when tested in conformance with ASTM E 84.
2. Radiant Flux Classification: resilient accessories having an average critical radiant flux value of at least 0.45 (Class I), when tested in conformance with ASTM E 648.

C. Qualifications:
1. Installer: Company or individuals must have at least 5 years' experience installing resilient base and accessories for at least 30 previous projects similar to this project in size, material, design, and complexity.
2. Supervisors: Individuals must have at least 7 years' experience installing resilient base and accessories for at least 30 previous projects similar to this project in size, material, design, and complexity, including at least 2 years' supervisory experience directing and leading resilient base and accessory installers.

1.6 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
2. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items as shipped, upright in their original containers, indoors within dry, well-ventilated, broom-cleaned, and partially- or permanently-enclosed storage areas.
1. Sheet products must be tightly rolled face out on a sturdy core designed for that purpose and vertically stored unless otherwise required or recommended by the manufacturer
2. Promptly remove and replace rolled sheet products that are flattened or distorted during shipping, unloading, or storage.

C. Handling: Handle items in conformance with manufacturer's instructions and other requirements and recommendations.
1. Avoid damage to containers and contamination of contents.
2. Rotate inventory; do not use items the shelf life of which is expired.

D. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective resilient base and accessories with undamaged new resilient base and accessories that do not exhibit deterioration, damage, or defects, including rolled sheet products that are flattened or distorted during shipping, unloading, or storage.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

1.7 PROJECT CONDITIONS

A. Ambient Conditions: Install resilient base and accessories only when ambient temperature, RH, and other environmental conditions fall within ranges required, recommended, or accepted by the manufacturer.

B. Existing Conditions:
   1. Surface Conditions: Surfaces receiving resilient base and accessories must be dry. Install resilient base and accessories only when substrate moisture content, vapor emission rate, and surface temperature fall within ranges required, recommended, or accepted by the manufacturer.
   2. Ventilation: Maintain adequate ventilation during and after installation and curing, setting, or drying. Where natural ventilation is inadequate, use forced-air circulation or mechanical ventilation as necessary for the installations indicated.
   3. Illumination: Provide permanent lighting or illuminate work spaces to at least the same type, illumination level, and color temperature maintained in the room or space after the building is occupied.

C. Other Conditions: Do not apply resilient base and accessories where dust is generated, or liquids are sprayed.

PART 2 - PRODUCTS

2.1 RESILIENT WALL BASE

A. Description: Solid thermoset vulcanized SBR rubber base conforming to ASTM F 1861 requirements for Type TS (vulcanized thermoset rubber), Group 1-solid (homogenous), Styles A (straight base) and B (cove base).

B. Manufacturers: Provide products manufactured by one of the following, or equal.
   1. Burke Flooring.
   2. Flexco Inc.
   3. Tarkett USA.

C. Product: “Johnsonite Wall Base Duracove Thermoplastic Rubber” manufactured by Tarkett USA, or equal.

D. Requisite Properties:
   1. Size: 4 inches high.
   2. Minimum Thickness: At least 0.125-inch thick.
   3. Profiles: Style A (straight base) at carpeting; provide Style B (cove base) at all other flooring, unless otherwise indicated.
   4. Colors: Indicated on the Drawings.
   5. Lengths: at least 120-foot coiled lengths. Provide at least 4-foot straight lengths.
   6. Corners: job-formed inside and outside corners.

2.2 RESILIENT FLOOR TRANSITION MOLDINGS

A. Description: PVC transitional molding profiles designed to finish edge of floor covering material to base and accessory surface and to transition between floor covering materials.

B. Products: “Finishing Accessories” manufactured by Johnsonite, or equal.
   1. Material to Floor Reducers: Model No. “CRS-XX” and “RRS-XX” reducers, or equal.
   2. Material to Material Reducers: Model No. “SSR-XX” reducers, or equal.
   3. Slim Line Transitions: Model No. “SLTC-XX” transitions, or equal.
   4. Edge Guards: Model No. “EG-XX” guards, or equal.
   5. Wheeled Traffic Transitions: Model No. “CTA-XX” transitions, or equal.

C. Requisite Properties:
   1. Minimum Sizes: Indicated on the Drawings.
   2. Colors: Indicated on the Drawings.

2.3 INSTALLATION MATERIALS

A. Primer: Water-based, low- or zero-VOC, solvent-free primer supplied, required, recommended, or accepted by the manufacturer for in-service installation conditions, including temperature, relative humidity, and substrate porosity; and expected foot traffic, rolling traffic, and fire-resistance ratings.

B. Adhesive:
   1. Water-based, low- or zero-VOC adhesive supplied, required, recommended, or accepted by the manufacturer for ease of installation; and for adequate bonding of resilient base and accessories to substrates for all in-service installation conditions, including temperature, relative humidity, and substrate porosity; and expected foot traffic, rolling traffic, and fire-resistance ratings.
   2. Wet-tack, percent solids, open-time, stripability, and ease of application must be explicitly formulated for each resilient base and accessory type and application.

3. Provide hard-set adhesive supplied, required, recommended, or accepted by the manufacturer under resilient base and accessories subject to concentrated static or dynamic rolling loads.

2.4 ACCESSORIES

A. Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification:
   1. Verify in-place construction, project conditions, and the work of other specification sections conform to the manufacturer's instructions and other requirements and recommendations. Verify subfloor surfaces are properly secured, smooth, and flat to minimum floor flatness and levelness tolerances required, recommended, or accepted by the manufacturer for the actual in-service conditions applicable to the project.
   2. Verify substrates are dry and free of curing compounds, sealers, hardeners, and deleterious and other substances that might interfere with resilient base and accessory adhesion, appearance, or performance.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.
   2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 PREPARATION

A. Substrate Preparation: Prepare substrates as required, recommended, or accepted by the manufacturer without limitation; and in a manner that does not result in any warranty or guarantee becoming void.

3.3 INSTALLATION

A. General Requirements:
   1. Install resilient base and accessories using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
   2. Only install resilient base and accessories under conditions that ensure finishes are free from blemishes and defects.
   3. Completed work must match approved samples and mockups, as accepted by the Architect.
   4. Installed resilient base and accessories must be warrantable. Do not install, correct, or replace resilient base and accessories in a manner that results in any warranty or guarantee becoming void.

B. Resilient Base Special Techniques:
   1. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
   2. Install resilient base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.
   3. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
   4. Do not stretch resilient base during installation.
   5. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
   6. Use straight pieces of maximum lengths possible to form corners; form without producing discoloration (whitening) at bends.

C. Transitional Moldings Special Techniques: Butt resilient transitional moldings to adjacent materials, and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of resilient base and accessory that would otherwise be exposed.

D. Interface with Adjacent Items: Provide materials, components, and accessories normally furnished or necessary to securely adhere resilient base and accessories to supporting construction.

3.4 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
   1. written descriptions of non-conforming, damaged, and defective work;
   2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
   3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.5 CLEANING

A. Cleaning Work: Clean all visible resilient base and accessory surfaces in a manner that does not result in any warranty or guarantee becoming void.
   1. Use cleaning materials, equipment, and accessories supplied, and means, methods, techniques, and procedures required, recommended, or accepted by the manufacturer.
   2. Do not use cleaning materials or procedures known to change, or that might change, the appearance of exposed finishes or adjacent surfaces; or cause deterioration or damage to exposed finishes or adjacent surfaces.
   3. Protect adjacent surfaces not being cleaned from staining, deterioration, damage, or other detrimental effects caused by cleaning.
   4. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be cleaned to the Architect's acceptance.

B. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

3.6 PROTECTION

A. Protect installed resilient base and accessories in place from soiling, deterioration, and damage until Substantial Completion.

B. Do not store anything on, adjacent to, or against installed resilient base and accessories unless they are protected from damage, as accepted in writing by the manufacturer's representative. Do not use installed resilient base and accessories as work surfaces.

C. Remove protection when it's no longer needed and before Substantial Completion.

END OF SECTION

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SECTION 09 65 16 – RESILIENT SHEET FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Resilient sheet flooring.
   2. Surface preparation.
   3. Installation materials.
   4. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

B. Related Requirements:
   1. Section 09 05 16 for preparation of concrete slabs for finish flooring; and for remedial MVER products.

1.2 REFERENCES

A. Abbreviations and Acronyms:
   1. ICRI: International Concrete Repair Institute, Inc.
   2. MVER: Moisture Vapor Emission Rate.
   3. RFCI: Resilient Floor Covering Institute.

B. Definitions:
   1. Manufacturer: Means the resilient sheet flooring manufacturer, unless otherwise indicated.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Concrete Substrates:
      a. Verify chemical and adhesive compatibility of selected flooring adhesives with installed curing compounds and installed moisture vapor emission control systems, based on current product formulations.
      b. Coordinate existing concrete subfloor surface flatness and levelness with ACI 117 requirements, measured in conformance with ASTM E 1155 (3D laser scanning or Allen Face F-Meter methods), and tolerances required, recommended, or accepted by the flooring manufacturer.
   2. Wood Substrates: Verify all wood sub floors are double-layer construction, are suspended at least 18 inches above grade, and have adequate cross-ventilation.

B. Preinstallation Meeting:
   1. Resilient sheet flooring manufacturer's representative and installer must attend the preinstallation meeting .
   2. Schedule a separate additional preinstallation meeting between the Contractor, the Architect, resilient sheet flooring manufacturer's representatives and installers, and the entities and individuals responsible for conducting concrete substrate testing.
   3. Hold the meeting after submittal approval and at least 10 business days before beginning installation.
   4. During the meeting, review the Contract Documents, submittals, project conditions, and installation sequence and methods, including subfloor surface flatness and levelness, and special details and conditions that might affect installation.
   5. Identify and discuss adverse or unfavorable conditions detrimental to protecting stored materials or to installation; or to the quality, durability, appearance, or performance of installed resilient sheet flooring. Resolve each condition.
   6. Finalize construction schedule.
   7. Record significant discussions and distribute meeting minutes. Do not begin installation until disagreements are successfully resolved to the satisfaction of all parties.

C. Sequencing:
   1. Schedule resilient sheet flooring deliveries to the project site only after the building is enclosed with a permanent enclosure; "wet work" within storage areas (including concrete, cast underlayment, mortaring, grouting, plastering, and gypsum board finishing) is complete and cured or dried to a condition of equilibrium; storage areas are broom- and vacuum-clean; and the HVAC system is activated, operating, and maintaining ambient conditions at occupancy levels.
   2. Install resilient sheet flooring only after substrate is cured to a condition of equilibrium; is sufficiently dry to bond with resilient sheet flooring adhesives; and has alkalinity (pH), MVER, and RH within ranges required, recommended, or accepted by the manufacturer. Provide chemically and adhesively compatible treatment when required or necessary to reduce pH and MVER to within allowable limits required, recommended, or accepted by the manufacturer.
   3. Final light fixtures must be completely installed and energized before beginning installation.
   4. Install resilient sheet flooring only after penetrating items are installed.
   5. Install resilient sheet flooring only after all other finishing operations are complete, especially overhead finishes.
   6. After resilient sheet flooring installation, maintain ambient conditions within a range required, recommended, approved, or accepted by the manufacturer until Final Completion.

D. Scheduling:
   1. Concrete Curing: Allow enough time in the construction schedule for concrete to cure for at least 28 days before beginning surface preparation and installation.

2. Acclimation: Allow sufficient time in the construction schedule to acclimate resilient sheet flooring and installation materials to specified ambient conditions for at least 48 hours before installation begins.
3. Primer Installation: Resilient sheet flooring must be applied within 24 hours of primer installation. Re-prime surfaces exposed for more than 24 hours; follow manufacturer's instructions for re-priming.
4. Access Restrictions: Close spaces during installation; keep closed to foot traffic after installation for at least 48 hours and to rolling traffic for at least 72 hours.

1.4 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data: Submit manufacturer's product data, specifications, typical installation details, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs), and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
   2. Shop Drawings:
      a. Submit dimensioned plans drawn to scale and showing resilient sheet flooring custom patterns and inlays, and seam layouts.
      b. Include project-specific dimensioned details drawn to scale showing conditions not detailed on the product data; or that are detailed, but not in a manner specific to the project. Cross-reference details to plans.
   3. Material Samples:
      a. Submit at least 8-inch square representative samples of each resilient sheet flooring color, finish, and variety.
      b. Submit at least 8-inch long representative samples of each welding rod selected or required for each resilient sheet flooring color, finish, and variety.
   4. Seam Samples:
      a. Submit at least 8- by 10-inch samples of each seam required for each resilient sheet flooring color, finish, and variety, with seam in center of each sample.
      b. Samples are representative samples of actual finishes, and must be prepared by the same installer's personnel designated to perform the work of this specification section.

B. Informational Submittals: Submit the following for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
   1. Manufacturer's Instructions: Submit manufacturer-prepared published instructions for proper installation of furnished resilient sheet flooring.
      a. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.

b. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.

2. Qualification Statements: Submit written descriptions confirming experience specified in QUALITY ASSURANCE article below.

C. Closeout Submittals: Submit copies of manufacturer's instructions and other requirements and recommendations for resilient sheet flooring maintenance, cleaning, and repair to the Architect as a condition of project closeout.

D. Maintenance Material Submittals:

1. Before Final Completion, deliver to the Owner resilient sheet flooring cleaning materials, equipment, accessories, and instructions; and extra stock materials to replace those worn or damaged as a result of normal occupancy.
2. Furnish at least 2 percent of the total installed for each resilient sheet flooring type, color, composition, grade, finish, and variety, but not less than one unopened box or container.

1.5 QUALITY ASSURANCE

A. Source Limitations:

1. Resilient sheet flooring must be obtained through one source from the same manufacturer (to ensure compatibility, regulatory conformance, and a warrantable installation).
   a. Certain items may be obtained from more than one manufacturer, but only when used for separate installations.
   b. Items provided for each different installation must be obtained from the same source and manufacturer.
2. Provide secondary materials, components, accessories and other items from sources required, recommended, or accepted by the primary manufacturer for actual in-service conditions applicable to the project.

B. Regulatory Requirements:

1. Resilient sheet flooring must be stable, firm, and slip resistant, conforming to the requirements of California Building Code Section 11B-302.1
2. Radiant Flux Classification: Provide resilient sheet flooring having an average critical radiant flux value of at least 0.45 (Class I), when tested in conformance with ASTM E 648.
3. Allowable Static Coefficient of Friction Value (SCOF): At least 0.6 for level surfaces and at least 0.8 for sloped surfaces, when measured in conformance with ASTM D 2047.
4. Allowable Dynamic Coefficient of Friction Value (DCOF): Between 0.35 and 0.45, when measured in conformance with ANSI B101.3 under wet conditions.

C. Quality Standards:

1. Resilient Sheet Flooring Installation Standard: Comply with Resilient Floor Covering Institute publication RFCI IP #1, "*Recommended Installation Practice for Homogeneous Sheet Flooring, Fully-Adhered*" requirements that apply to each in-service condition indicated.
2. Material Standard: Resilient sheet flooring must be independently tested and certified by Scientific Certification Systems (SCS) in conformance with FloorScore requirements for indoor air quality emissions.

D. Qualifications:
1. Installer: Company or individuals must have at least 5 years' experience installing resilient sheet flooring for at least 30 previous projects similar to this project in size, material, design, and complexity.
2. Supervisors: Individuals must have at least 7 years' experience installing resilient sheet flooring for at least 30 previous projects similar to this project in size, material, design, and complexity, including at least 2 years' supervisory experience directing and leading resilient sheet flooring installers.

E. Custom Patterns and Inlays: Resilient sheet flooring must be laser-cut. Field cutting is prohibited.

1.6 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
2. Reject items that are not transported, delivered, or protected in conformance with manufacturer-recommended transport, delivery, and receiving requirements.
3. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items indoors as shipped, upright in their original packaging or containers, within dry, well-ventilated, broom-cleaned and enclosed storage areas.
1. Furnish adequate dunnage and bracing during storage.
2. Prevent stored items from contacting the floor, from soiling and staining, and from deterioration and damage.
3. Sheet products must be tightly rolled face out on a sturdy core designed for that purpose and vertically stored unless otherwise required or recommended by the manufacturer. Promptly remove and replace rolled sheet products that are flattened or distorted during shipping, unloading, or storage.
4. Do not leave items uncovered where they might be exposed to weather or become wet; or exposed to heat or sudden changes in temperature or relative humidity; or other sources of deterioration and damage, including dust and other airborne contaminants.

C. Handling: Handle items in conformance with manufacturer's instructions and other requirements and recommendations, and in a manner that that prevents damage.

1. Avoid damage to packaging and containers, and contamination of contents.
2. Rotate inventory; do not use items the shelf life of which is expired.

D. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective resilient sheet flooring materials with undamaged new resilient sheet flooring materials that do not exhibit deterioration, damage, or defects.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

1.7 PROJECT CONDITIONS

A. Ambient Conditions: Install resilient sheet flooring only when ambient temperature, RH, and other environmental conditions fall within ranges required, recommended, or accepted by the manufacturer.

B. Existing Conditions:
1. Surface Conditions: Surfaces receiving resilient sheet flooring must be dry. Install resilient sheet flooring only when substrate moisture content, vapor emission rate, and surface temperature fall within ranges required, recommended, or accepted by the manufacturer.
2. Ventilation: Maintain adequate ventilation during and after installation and curing, setting, or drying. Where natural ventilation is inadequate, use forced-air circulation or mechanical ventilation as necessary for the installations indicated.
3. Illumination: Provide permanent lighting or illuminate work spaces to at least the same type, illumination level, and color temperature maintained in the room or space after the building is occupied.

PART 2 - PRODUCTS

2.1 VINYL SHEET FLOORING

A. Products: Indicated on the Drawings in the Finish Schedule Sheet IE601, or equal.

2.2 SURFACE PREPARATION

A. Substrate Testing and Surface Preparation: Perform testing and corrective work and prepare substrates in conformance with the requirements of Section 09 05 16.

2.3 INSTALLATION MATERIALS

A. Trowelable Patch and Fill Materials: Specified in Section 03 54 16, unless other products are supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

B. Moisture Vapor Transmission Reduction Coating: Specified in Section 09 05 16 (remedial), unless another coating is supplied, required, recommended, accepted by the by manufacturer for actual in-service conditions applicable to the project.

C. Primer: Water-based, low- or zero-VOC, solvent-free primer supplied, required, recommended, or accepted by the manufacturer for in-service installation conditions, including temperature, relative humidity, and substrate porosity; and expected foot traffic, rolling traffic, and fire-resistance ratings.

D. Adhesive:
   1. Water-based, low- or zero-VOC adhesive supplied, required, recommended, or accepted by the manufacturer for ease of resilient sheet flooring installation; and for adequate bonding of resilient sheet flooring to substrates for all in-service installation conditions, including temperature, relative humidity, and substrate porosity; and expected foot traffic, rolling traffic, and fire-resistance ratings.
   2. Wet-tack, percent solids, open-time, stripability, and ease of application must be explicitly formulated for each resilient sheet flooring type and application.
   3. Provide hard-set adhesive supplied, required, recommended, or accepted by the manufacturer under resilient sheet flooring subject to concentrated static or dynamic rolling loads.

E. Integral Flash Cove Base Accessories: Provide the following manufactured by Johnsonite, or equal.
   1. Cove Filler Strips:
      a. 1-3/4-inch Radius: “Model No. CFS-00”, or equal.
      b. 1-1/4-inch Radius: “Model No. CFS-00-A”, or equal.
      c. One-inch Radius: “Model No. CFS-00-M”, or equal.
   2. Cove Caps: “Model No. SCC-55-A”, or equal.

F. Welding Rods:
   1. Description: Manufacturer's standard solid-strand, solidified adhesive, through-color welding rods. Match flooring color, pattern, and appearance.
   2. Colors: Indicated on the Drawings or selected by the Architect.
   3. Requisite Properties:
      a. Provide matching solid colors for solid color flooring.
      b. Provide pattern-matching non-solid colors for patterned flooring.

2.4 ACCESSORIES

A. Subfloor Leveler System:
   1. Products: Provide the following manufactured by Johnsonite, or equal.
      a. Reduces 1/8-inch to Zero: “Model No. LS-40-F”, or equal.
      b. Reduces 1/4-inch to Zero (can be cut at score line to reduce height as indicated): “Model No. LS-40”, or equal.

c. Reduces 1/4-inch to Zero (leveled edge for tack strip installation): “Model No. LS-40-K”, or equal.
d. Reduces 3/8-inch to Zero (can be cut at score line to reduce height as indicated): “Model No. LS-40-D”, or equal.
e. Reduces 1/2-inch to Zero (can be cut at score line to reduce height as indicated): “Model No. LS-40-E”, or equal.
f. Reduces 3/4-inch to Zero: “Model No. LS-40-G”, or equal.
g. Reduces 3/8-inch to 1/4-inch (can be used alone or with LS-40 to extend transition): “Model No. LS-40-B”, or equal.
h. Reduces 1/2-inch to 3/8-inch (can be used alone or with Model Nos. “LS-40-D” or “LS-40-D” to extend transition): “Model No. LS-40-C”, or equal.

B. Leveling Paper:
1. Application: Used to align finish surfaces of 2.0mm and 3.0mm flooring.
2. Description: Kraft or felt paper supplied, required, recommended, or accepted by the manufacturer.

C. Cleaner: Supplied, required, recommended, or accepted by the manufacturer for use on the installed resilient sheet flooring and actual in-service conditions applicable to the project. Cleaners must remove stains, dirt, and residue without damaging or altering resilient sheet flooring surfaces.

D. Floor Polish: Protective liquid polish products supplied, required, recommended, or accepted by the manufacturer for the actual in-service conditions applicable to the project.

E. Other Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification:
1. Verify in-place construction, project conditions, and the work of other specification sections conform to the manufacturer’s instructions and other requirements and recommendations.
2. Verify subfloor surfaces are properly secured, smooth, and flat to minimum floor flatness and levelness tolerances required, recommended, or accepted by the manufacturer for the actual in-service conditions applicable to the project.

3. Verify substrates are dry and free of curing compounds, sealers, hardeners, and deleterious and other substances that might interfere with resilient sheet flooring adhesion, appearance, or performance.
4. Verify items penetrating resilient sheet flooring are installed.

C. Evaluation and Assessment:
1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.
2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 PREPARATION

A. Protection:
1. Work Area Protection: Protect work areas from dust and other airborne contaminants during surface preparation and resilient sheet flooring installation. Control and collect dust produced by grinding operations.
2. Adjacent Material Protection: Protect adjacent surfaces against soiling and damage, and from detrimental effects caused by surface profiling operations. Utilize drop cloths, shields, masking, barricades, and other items necessary to protect adjacent surfaces.

B. Substrate Preparation: Prepare substrates as required, recommended, or accepted by the manufacturer without limitation; and in a manner that does not result in any warranty or guarantee becoming void.
1. Remove substrate coatings and other substances that are incompatible with adhesives or that may negatively affect the quality of the installation, durability, appearance, or performance of either the furnished resilient sheet flooring or adhesives.
2. Remove sub-floor ridges and bumps. Fill minor or local low spots, cracks, joints, holes, and other defects with patch and fill materials. Apply, trowel, and float patch material to achieve smooth, flat, hard surface. Prohibit traffic until patch material is cured.
3. Perform testing, corrective work, and substrate preparation specified in Section 09 05 16.
4. Vacuum-clean substrate.

C. Bond Test: Perform and document bond tests as required, recommended, or accepted by the manufacturer, must be performed and documented before beginning installation.

3.3 INSTALLATION

A. General Requirements:

1. Install resilient sheet flooring using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
2. Only install resilient sheet flooring under conditions that ensure finishes are free from blemishes and defects.
3. Completed work must match approved samples and mockups, as accepted by the Architect.
4. Installed resilient sheet flooring must be warrantable. Do not install, correct, or replace resilient sheet flooring in a manner that results in any warranty or guarantee becoming void.

B. Special Techniques:
1. Scribe, cut, and fit resilient sheet flooring to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
2. Extend resilient sheet flooring into toe spaces, door reveals, closets, and similar openings. Extend resilient sheet flooring to centerline of doors in the closed position.
3. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on resilient sheet flooring as marked on substrates. Use pencil, chalk, or other nonpermanent, non-staining marking device. The use of markers is prohibited.
4. Adhere resilient sheet flooring to substrate using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
5. For seamless resilient sheet flooring installation, rout seams and weld together with coordinated color heat welding rod in conformance with the manufacturer's instructions.

C. Interface with Adjacent Items: Provide materials, components, and accessories normally furnished or necessary to securely adhere resilient sheet flooring to supporting construction.

3.4 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
1. written descriptions of non-conforming, damaged, and defective work;

2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.5 CLEANING

A. Cleaning Work: Clean all visible resilient sheet flooring surfaces in a manner that does not result in any warranty or guarantee becoming void.
1. Use cleaning materials, equipment, and accessories supplied, and means, methods, techniques, and procedures required, recommended, or accepted by the manufacturer.
2. Do not use cleaning materials or procedures known to change, or that might change, the appearance of exposed finishes or adjacent surfaces; or cause deterioration or damage to exposed finishes or adjacent surfaces.
3. Protect adjacent surfaces not being cleaned from staining, deterioration, damage, or other detrimental effects caused by cleaning.
4. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be cleaned to the Architect's acceptance.

B. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

3.6 PROTECTION

A. Protect installed resilient sheet flooring in place from soiling, deterioration, and damage until Substantial Completion.

B. Do not store anything on, adjacent to, or against installed resilient sheet flooring unless it is protected from damage, as accepted in writing by the manufacturer's representative. Do not use installed resilient sheet flooring as work surfaces.

C. Remove protection when it's no longer needed and before Substantial Completion.

END OF SECTION

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Project Manual

100% Construction Documents

NEW CARDIAC CATHETERIZATION LAB SUITE & HYPERBARIC FACILITY EXPANSION RIVERSIDE UNIVERSITY HEALTH SYSTEM

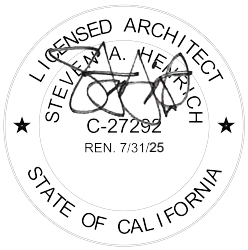
26520 Cactus Avenue
Moreno Valley, CA 92555

HCAI #S231455-33-00

(Package 2 of 4: Sections 09 65 23 thru 13 49 13)

Leo A. Daly
Project No. 047-10071-002
October 10, 2023

SECTION 00 01 07 – SEALS PAGE

 Stamp & Signature of Architect of Record	 Stamp & Signature of Structural Engineer of Record
 Stamp & Signature of Mechanical Engineer of Record	 Stamp & Signature of Electrical Engineer of Record



SECTION 09 65 23 – RESILIENT PLANK FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Resilient plank flooring.
   2. Surface preparation.
   3. Installation materials.
   4. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

B. Related Requirements:
   1. Section 09 05 16 for preparation of concrete slabs for finish flooring; and for remedial MVER products.

1.2 REFERENCES

A. Abbreviations and Acronyms:
   1. ICRI: International Concrete Repair Institute, Inc.
   2. MVER: Moisture Vapor Emission Rate.
   3. RFCI: Resilient Floor Covering Institute.

B. Definitions:
   1. Manufacturer: Means the resilient plank flooring manufacturer, unless otherwise indicated.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Concrete Substrates:
      a. Verify chemical and adhesive compatibility of selected flooring adhesives with installed curing compounds and installed moisture vapor emission control systems, based on current product formulations.
      b. Coordinate existing concrete subfloor surface flatness and levelness with ACI 117 requirements, measured in conformance with ASTM E 1155 (3D laser scanning or Allen Face F-Meter methods), and tolerances required, recommended, or accepted by the flooring manufacturer.
   2. Wood Substrates: Verify all wood sub floors are double-layer construction, are suspended at least 18 inches above grade, and have adequate cross-ventilation.

B. Preinstallation Meeting:
   1. Resilient plank flooring manufacturer's representative and installer must attend the preinstallation meeting.
   2. Schedule a separate additional preinstallation meeting between the Contractor, the Architect, resilient plank flooring manufacturer's representatives and installers, and the entities and individuals responsible for conducting concrete substrate testing.
   3. Hold the meeting after submittal approval and at least 10 business days before beginning installation.
   4. During the meeting, review the Contract Documents, submittals, project conditions, and installation sequence and methods, including subfloor surface flatness and levelness, and special details and conditions that might affect installation.
   5. Identify and discuss adverse or unfavorable conditions detrimental to protecting stored materials or to installation; or to the quality, durability, appearance, or performance of installed resilient plank flooring. Resolve each condition.
   6. Finalize construction schedule.
   7. Record significant discussions and distribute meeting minutes. Do not begin installation until disagreements are successfully resolved to the satisfaction of all parties.

C. Sequencing:
   1. Schedule resilient plank flooring deliveries to the project site only after the building is enclosed with a permanent enclosure; "wet work" within storage areas (including concrete, cast underlayment, mortaring, grouting, plastering, and gypsum board finishing) is complete and cured or dried to a condition of equilibrium; storage areas are broom- and vacuum-clean; and the HVAC system is activated, operating, and maintaining ambient conditions at occupancy levels.
   2. Install resilient plank flooring only after substrate is cured to a condition of equilibrium; is sufficiently dry to bond with resilient plank flooring adhesives; and has alkalinity (pH), MVER, and RH within ranges required, recommended, or accepted by the manufacturer. Provide chemically and adhesively compatible treatment when required or necessary to reduce pH and MVER to within allowable limits required, recommended, or accepted by the manufacturer.
   3. Final light fixtures must be completely installed and energized before beginning installation.
   4. Install resilient plank flooring only after penetrating items are installed.
   5. Install resilient plank flooring only after all other finishing operations are complete, especially overhead finishes.
   6. After resilient plank flooring installation, maintain ambient conditions within a range required, recommended, approved, or accepted by the manufacturer until Final Completion.

D. Scheduling:
   1. Concrete Curing: Allow enough time in the construction schedule for concrete to cure for at least 28 days before beginning surface preparation and installation.

2. Acclimation: Allow sufficient time in the construction schedule to acclimate resilient plank flooring and installation materials to specified ambient conditions for at least 48 hours before installation begins.
3. Primer Installation: Resilient plank flooring must be applied within 24 hours of primer installation. Re-prime surfaces exposed for more than 24 hours; follow manufacturer's instructions for re-priming.
4. Access Restrictions: Close spaces during installation; keep closed to foot traffic after installation for at least 48 hours and to rolling traffic for at least 72 hours.

1.4 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data: Submit manufacturer's product data, specifications, typical installation details, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs), and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
   2. Shop Drawings:
      a. Submit dimensioned plans drawn to scale and showing resilient plank flooring custom patterns and inlays, and seam layouts.
      b. Include project-specific dimensioned details drawn to scale showing conditions not detailed on the product data; or that are detailed, but not in a manner specific to the project. Cross-reference details to plans.
   3. Samples: Submit at least 8-inch square representative samples of each resilient plank flooring color, finish, and variety.

B. Informational Submittals: Submit the following for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
   1. Manufacturer's Instructions: Submit manufacturer-prepared published instructions for proper installation of furnished resilient plank flooring.
      a. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.
      b. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.
   2. Qualification Statements: Submit written descriptions confirming experience specified in QUALITY ASSURANCE article below.

C. Closeout Submittals: Submit copies of manufacturer's instructions and other requirements and recommendations for resilient plank flooring maintenance, cleaning, and repair to the Architect as a condition of project closeout.

D. Maintenance Material Submittals:

1. Before Final Completion, deliver to the Owner resilient plank flooring cleaning materials, equipment, accessories, and instructions; and extra stock materials to replace those worn or damaged as a result of normal occupancy.
2. Furnish at least 2 percent of the total installed for each resilient plank flooring type, color, composition, grade, finish, and variety, but not less than one unopened box or container.

1.5 QUALITY ASSURANCE

A. Source Limitations:
   1. Resilient plank flooring must be obtained through one source from the same manufacturer (to ensure compatibility, regulatory conformance, and a warrantable installation).
      a. Certain items may be obtained from more than one manufacturer, but only when used for separate installations.
      b. Items provided for each different installation must be obtained from the same source and manufacturer.
   2. Provide secondary materials, components, accessories and other items from sources required, recommended, or accepted by the primary manufacturer for actual in-service conditions applicable to the project.

B. Regulatory Requirements:
   1. Resilient plank flooring must be stable, firm, and slip resistant, conforming to the requirements of California Building Code Section 11B-302.1
   2. Radiant Flux Classification: Provide resilient plank flooring having an average critical radiant flux value of at least 0.45 (Class I), when tested in conformance with ASTM E 648.
   3. Allowable Static Coefficient of Friction Value (SCOF): At least 0.6 for level surfaces and at least 0.8 for sloped surfaces, when measured in conformance with ASTM D 2047.
   4. Allowable Dynamic Coefficient of Friction Value (DCOF): Between 0.35 and 0.45, when measured in conformance with ANSI B101.3 under wet conditions.

C. Quality Standards:
   1. Resilient Plank Flooring Installation Standard: Comply with Resilient Floor Covering Institute publication RFCI IP #2, "*Recommended Installation Practice for Vinyl Composition Plank (VCT)*" requirements that apply to each in-service condition indicated.
   2. Material Standard: Resilient plank flooring must be independently tested and certified by Scientific Certification Systems (SCS) in conformance with FloorScore requirements for indoor air quality emissions.

D. Qualifications:

1. Installer: Company or individuals must have at least 5 years' experience installing resilient plank flooring for at least 30 previous projects similar to this project in size, material, design, and complexity.
2. Supervisors: Individuals must have at least 7 years' experience installing resilient plank flooring for at least 30 previous projects similar to this project in size, material, design, and complexity, including at least 2 years' supervisory experience directing and leading resilient plank flooring installers.

E. Custom Patterns and Inlays: Resilient plank flooring must be laser-cut. Field cutting is prohibited.

1.6 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
2. Reject items that are not transported, delivered, or protected in conformance with manufacturer-recommended transport, delivery, and receiving requirements.
3. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items indoors as shipped, upright in their original packaging or containers, within dry, well-ventilated, broom-cleaned and enclosed storage areas.
1. Furnish adequate dunnage and bracing during storage.
2. Prevent stored items from contacting the floor, from soiling and staining, and from deterioration and damage.
3. Do not leave items uncovered where they might be exposed to weather or become wet; or exposed to heat or sudden changes in temperature or relative humidity; or other sources of deterioration and damage, including dust and other airborne contaminants.

C. Handling: Handle items in conformance with manufacturer's instructions and other requirements and recommendations, and in a manner that that prevents damage.
1. Avoid damage to packaging and containers, and contamination of contents.
2. Rotate inventory; do not use items the shelf life of which is expired.

D. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective resilient plank flooring materials with undamaged new resilient plank flooring materials that do not exhibit deterioration, damage, or defects.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

1.7 PROJECT CONDITIONS

A. Ambient Conditions: Install resilient plank flooring only when ambient temperature, RH, and other environmental conditions fall within ranges required, recommended, or accepted by the manufacturer.

B. Existing Conditions:
   1. Surface Conditions: Surfaces receiving resilient plank flooring must be dry. Install resilient plank flooring only when substrate moisture content, vapor emission rate, and surface temperature fall within ranges required, recommended, or accepted by the manufacturer.
   2. Ventilation: Maintain adequate ventilation during and after installation and curing, setting, or drying. Where natural ventilation is inadequate, use forced-air circulation or mechanical ventilation as necessary for the installations indicated.
   3. Illumination: Provide permanent lighting or illuminate work spaces to at least the same type, illumination level, and color temperature maintained in the room or space after the building is occupied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide products manufactured by one of the following, or equal.
   1. Armstrong World Industries.
   2. FLEXCO Corp.
   3. Johnsonite.

2.2 RESILIENT PLANK FLOORING

A. Products: Indicated on the Drawings, or equal.

2.3 SURFACE PREPARATION

A. Substrate Testing and Surface Preparation: Perform testing and corrective work and prepare substrates in conformance with the requirements of Section 09 05 16.

2.4 INSTALLATION MATERIALS

A. Trowelable Patch and Fill Materials: Specified in Section 03 54 16, unless other products are supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

B. Moisture Vapor Transmission Reduction Coating: Specified in Section 09 05 16 (remedial), unless another coating is supplied, required, recommended, accepted by the by manufacturer for actual in-service conditions applicable to the project.

C. Primer: Water-based, low- or zero-VOC, solvent-free primer supplied, required, recommended, or accepted by the manufacturer for in-service installation conditions, including temperature, relative humidity, and substrate porosity; and expected foot traffic, rolling traffic, and fire-resistance ratings.

D. Adhesive:
   1. Water-based, low- or zero-VOC adhesive supplied, required, recommended, or accepted by the manufacturer for ease of resilient plank flooring installation; and for adequate bonding of resilient plank flooring to substrates for all in-service installation conditions, including temperature, relative humidity, and substrate porosity; and expected foot traffic, rolling traffic, and fire-resistance ratings.
   2. Wet-tack, percent solids, open-time, stripability, and ease of application must be explicitly formulated for each resilient plank flooring type and application.
   3. Provide hard-set adhesive supplied, required, recommended, or accepted by the manufacturer under resilient plank flooring subject to concentrated static or dynamic rolling loads.

2.5 ACCESSORIES

A. Cleaner: Supplied, required, recommended, or accepted by the manufacturer for use on the installed resilient plank flooring and actual in-service conditions applicable to the project. Cleaners must remove stains, dirt, and residue without damaging or altering resilient plank flooring surfaces.

B. Floor Polish: Protective liquid polish products supplied, required, recommended, or accepted by the manufacturer for the actual in-service conditions applicable to the project.

C. Other Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification:

1. Verify in-place construction, project conditions, and the work of other specification sections conform to the manufacturer's instructions and other requirements and recommendations.
2. Verify subfloor surfaces are properly secured, smooth, and flat to minimum floor flatness and levelness tolerances required, recommended, or accepted by the manufacturer for the actual in-service conditions applicable to the project.
3. Verify substrates are dry and free of curing compounds, sealers, hardeners, and deleterious and other substances that might interfere with resilient plank flooring adhesion, appearance, or performance.
4. Verify items penetrating resilient plank flooring are installed.

C. Evaluation and Assessment:
1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.
2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 PREPARATION

A. Protection:
1. Work Area Protection: Protect work areas from dust and other airborne contaminants during surface preparation and resilient plank flooring installation. Control and collect dust produced by grinding operations.
2. Adjacent Material Protection: Protect adjacent surfaces against soiling and damage, and from detrimental effects caused by surface profiling operations. Utilize drop cloths, shields, masking, barricades, and other items necessary to protect adjacent surfaces.

B. Substrate Preparation: Prepare substrates as required, recommended, or accepted by the manufacturer without limitation; and in a manner that does not result in any warranty or guarantee becoming void.
1. Remove substrate coatings and other substances that are incompatible with adhesives or that may negatively affect the quality of the installation, durability, appearance, or performance of either the furnished resilient plank flooring or adhesives.
2. Remove sub-floor ridges and bumps. Fill minor or local low spots, cracks, joints, holes, and other defects with patch and fill materials. Apply, trowel, and float patch material to achieve smooth, flat, hard surface. Prohibit traffic until patch material is cured.
3. Perform testing, corrective work, and substrate preparation specified in Section 09 05 16.
4. Vacuum-clean substrate.

C. Bond Test: Perform and document bond tests as required, recommended, or accepted by the manufacturer, must be performed and documented before beginning installation.

3.3 INSTALLATION

A. General Requirements:
   1. Install resilient plank flooring using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
   2. Only install resilient plank flooring under conditions that ensure finishes are free from blemishes and defects.
   3. Completed work must match approved samples and mockups, as accepted by the Architect.
   4. Installed resilient plank flooring must be warrantable. Do not install, correct, or replace resilient plank flooring in a manner that results in any warranty or guarantee becoming void.

B. Special Techniques:
   1. Scribe, cut, and fit resilient plank flooring to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
   2. Extend resilient plank flooring into toe spaces, door reveals, closets, and similar openings. Extend resilient plank flooring to centerline of doors in the closed position.
   3. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on resilient plank flooring as marked on substrates. Use pencil, chalk, or other nonpermanent, non-staining marking device. The use of markers is prohibited.
   4. Adhere resilient plank flooring to substrate using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

C. Interface with Adjacent Items: Provide materials, components, and accessories normally furnished or necessary to securely adhere resilient plank flooring to supporting construction.

3.4 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
   1. written descriptions of non-conforming, damaged, and defective work;
   2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
   3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.5 CLEANING

A. Cleaning Work: Clean all visible resilient plank flooring surfaces in a manner that does not result in any warranty or guarantee becoming void.
   1. Use cleaning materials, equipment, and accessories supplied, and means, methods, techniques, and procedures required, recommended, or accepted by the manufacturer.
   2. Do not use cleaning materials or procedures known to change, or that might change, the appearance of exposed finishes or adjacent surfaces; or cause deterioration or damage to exposed finishes or adjacent surfaces.
   3. Protect adjacent surfaces not being cleaned from staining, deterioration, damage, or other detrimental effects caused by cleaning.
   4. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be cleaned to the Architect's acceptance.

B. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

3.6 PROTECTION

A. Protect installed resilient plank flooring in place from soiling, deterioration, and damage until Substantial Completion.

B. Do not store anything on, adjacent to, or against installed resilient plank flooring unless it is protected from damage, as accepted in writing by the manufacturer's representative. Do not use installed resilient plank flooring as work surfaces.

C. Remove protection when it's no longer needed and before Substantial Completion.

END OF SECTION

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SECTION 09 81 33 – ACOUSTICAL INSULATION, SEALANTS, AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Concealed acoustical insulation.
   2. Acoustical sealants.
   3. Acoustical spray.
   4. Firestop and acoustical putty pads.
   5. Installation materials.
   6. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

1.2 REFERENCES

A. Definitions:
   1. Manufacturer: Means the acoustical insulation or accessory manufacturer, as the context admits, manufacturer, unless otherwise indicated.

1.3 ADMINISTRATIVE REQUIREMENTS

A. CPVC Coordination: Not all CPVC products are identical. Different CPVC products from different manufacturers may vary in molecular weight, chlorine content and compound additives.
   1. Verify selected CPVC product combability with all products that may come into contact with selected CPVC, even if contact is inadvertent.
   2. Determine chemical composition of CPVC materials and compatibility of selected paints and sealants with selected CPVC materials.
   3. Only apply ancillary products that are specifically approved for use on the specific brand of CPVC selected for the project.
   4. If an ancillary product is not on a compatibility list, contact the CPVC manufacturer before use. Never assume the absence of a prohibition indicates suitability.
   5. Natural oil (vegetable oil or animal fat) and synthetic ester oils, or items containing natural or synthetic oil are prohibited from contacting CPVC.
   6. Plasticizers found in certain materials, including incompatible sealants, are prohibited from contacting CPVC.
   7. Surfactants found in certain materials, including soaps and detergents, are prohibited from contacting CPVC.

8. Fungicides sprayed on surrounding drywall and wood framing to prevent growth of mold and mildew, are prohibited from contacting CPVC.
9. Scented products, including cologne, perfume, or essential oils (e.g., peppermint oil, orange oil, spearmint oil, etc.), are prohibited from contacting CPVC. (Sometimes used for the purpose of being able to detect leaks by odor)
10. Jacketing on signal-carrying wiring systems often contains plasticizers that are prohibited from contacting CPVC.

1.4 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data: Submit manufacturer's product data, specifications, typical installation details, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs), and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.

B. Informational Submittals: Submit manufacturer's instructions for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
   1. Submit manufacturer-prepared published instructions for proper installation of furnished insulation.
   2. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.
   3. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.

1.5 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
   1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
   2. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items as shipped, upright in their original containers, indoors within dry, well-ventilated, broom-cleaned, and partially- or permanently-enclosed storage areas.

C. Damaged Item Replacement: Promptly remove and replace items that are deteriorated, damaged, or defective with undamaged new items that do not exhibit deterioration, damage, or defects.

D. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

1.6 PROJECT CONDITIONS

A. Existing Conditions: Surfaces receiving acoustical insulation must be dry.

PART 2 - PRODUCTS

2.1 CONCEALED ACOUSTICAL INSULATION

A. Acoustical Blanket Insulation:
   1. Description: Unfaced inorganic glass-fiber blanket acoustical insulation conforming to ASTM C 665 Type I acoustical insulation (blankets without membrane coverings).
   2. Manufacturers: Provide one of the following, or equal.
      a. “CertaPro AcoustaTherm” manufactured by CertainTeed Corp.
      b. “Sound Control Batts” manufactured by Johns Manville.
      c. “Sound Attenuation Batts/MW” manufactured by Owens Corning Fiberglass Corp.

B. Sound Attenuating Fire Blanket Insulation:
   1. Description: Asbestos-free mineral fiber blanket acoustical insulation conforming to ASTM C 665 requirements for Type I acoustical insulation (blankets without membrane coverings), manufactured from slag and naturally occurring rock.
   2. Products: Provide one of the following, or equal.
      a. “FIBREX Sound Attenuation Fire Batt Acoustical insulation (SAFB)” manufactured by Fibrex Insulations Inc.
      b. “Thermafiber Sound Attenuating Fire Blankets (SAFB)” manufactured by Owens Corning.
      c. “ROCKWOOL AFB” manufactured by Roxul Inc.

2.2 ACOUSTICAL SEALANTS

A. Latex Sealants:
   1. Description: Non-sag, paintable, non-staining siliconized acrylic-latex sealant conforming to ASTM C 834 requirements for Type OP (opaque sealant), Grade NF (does not meet the requirements for low temperature flexibility of Grade 0°C classification). Verify material compatibility with adjacent materials such as chlorinated polyvinyl chloride (CPVC) pipe.
   2. Application: Used where indicated at exposed and concealed joints and annular spaces around through-penetrations.
   3. Products: Unless another type is required, recommended, or accepted by the CPVC item manufacturer, provide one of the following, or equal.

a. "CP 506 Smoke and Acoustic Sealant" manufactured by Hilti, Inc.
b. "QuietZone Acoustic Sealant" manufactured by Owens Corning.
c. "AC-20 FTR" manufactured by Pecora Corp.
d. "Tremflex 834" manufactured by Tremco, Inc.
e. "Sheetrock Acoustical Sealant" manufactured by USG Corp.

4. Requisite Properties:
   a. Color: White.

B. Non-Drying, Non-Hardening, Non-Skinning Sealants:
   1. Description: Single-component butyl rubber sound dampening elastomeric sealant conforming to ASTM Standard D 217. Verify material compatibility with adjacent materials such as chlorinated polyvinyl chloride (CPVC) pipe.
   2. Application: Installed at concealed joints where indicated.
   3. Products: Unless another type is required, recommended, or accepted by the CPVC item manufacturer, provide one of the following, or equal.
      a. "BA-98" manufactured by Pecora Corp.
      b. "QuietSeal Acoustical Sealant QS-350" manufactured by Serious Materials, Inc.
      c. "Acoustical Sealant" manufactured by Tremco, Inc.

C. Fire Rated, Non-Hardening,, Sealant:
   1. Description: Verify material compatibility with adjacent materials such as chlorinated polyvinyl chloride (CPVC) pipe.
   2. Products: Unless another type is required, recommended, or accepted by the CPVC item manufacturer, provide one of the following, or equal.
      a. "Fire Barrier 2001 Silicone RTV Foam" manufactured by 3M.
      b. "CP 601S Elastomeric Firestop Sealant" manufactured by HILTI.
      c. "Firetemp CI Caulk" manufactured by Johns Manville.
      d. "Spec Seal ES100" manufactured by Specified Technologies, Inc.

D. Expanding Foam Sealant:
   1. Description: Gun-applied, expanding spray foam sealant. Verify material compatibility with adjacent materials such as chlorinated polyvinyl chloride (CPVC) pipe
   2. Application: Used to seal and insulate around common areas of energy loss, including foundation/sill plates, outdoor fixtures, pipe penetrations, etc.
   3. Products: Unless another type is required, recommended, or accepted by the CPVC item manufacturer, provide one of the following, or equal.
      a. "GREAT STUFF PRO Gaps & Cracks" manufactured by The Dow Chemical Co.
      b. "Polycell" manufactured by M-D Building Products, Inc.
      c. "Expanding Foam Polyfilla" manufactured by Polyfilla.

E. Cementitious Sealant: "Monokote Z-146" manufactured by GCP Applied Technologies, Inc., or equal.

F. Preformed Tape Sealants:
   1. Fire-Resistance Rated Conditions:
      a. Description: Compressible, self-extinguishing, UL-listed closed cell polyvinyl chloride foam tape with pressure sensitive adhesive.
      b. Application: Installed at concealed joints in fire-resistance rated construction, where indicated.
      c. Product: “Norseal V740FR” manufactured by Norton Performance Plastics Corp., or equal.
      d. Requisite Properties:
         1) Size: One-inch minimum roll width, unless another width is indicated on the Drawings.
         2) Thickness: At least 1/8-inch, unless another thickness is indicated on the Drawings.
         3) Density: At least 9 pounds per cubic foot.
         4) Facing: Furnish tape in rolls with protective release liner on non-adhesive face.
   2. Elsewhere:
      a. Description: Compressible, closed cell polyvinyl chloride foam tape with pressure sensitive adhesive.
      b. Application: Installed at concealed joints, where indicated.
      c. Product: “Norseal V730” manufactured by Norton Performance Plastics Corp., or equal.
      d. Requisite Properties:
         1) Size: One-inch minimum roll width.
         2) Thickness: At least 3/8-inch.
         3) Density: At least 6 pounds per cubic foot.
         4) Facing: Furnish tape in rolls with protective release liner on non-adhesive face.

2.3 ACOUSTICAL SPRAY

A. Description: Sprayable acrylic latex material.

B. Application: Used where indicated at exposed and concealed static or minimally dynamic joints or gaps in wall construction.

C. Products: Provide one of the following, or equal.
   1. “CP 572 Smoke and Acoustic Spray” or “CFS-SP WB Firestop Joint Spray” manufactured by Hilti, Inc.
   2. “Spec Seal Smoke ‘N’ Sound Sealant” manufactured by Specified Technologies, Inc.
   3. “TREMstop Smoke & Sound Sealant” or “TREMstop Acrylic” manufactured by Tremco, Inc.

D. Requisite Properties:
   1. Spray must be mold and mildew resistant in conformance with ASTM G21.
   2. Spray must have a minimum movement capability of at least 12.5 percent.

2.4 FIRESTOP AND ACOUSTICAL PUTTY PADS

A. Description: Sound deadening pads.

B. Application: Used to seal the external surfaces (back side) of metallic and nonmetallic switch and receptacle boxes to reduce airborne sound transmission in interior partitions.

C. Fire-Resistance Rated Construction (Firestop Putty Pads): Provide one of the following, or equal.
   1. “CP 617 Firestop Putty Pads” manufactured by Hilti, Inc.
   2. “Putty Pads” manufactured by International Protective Coatings
   3. “Type FSP Firestop Putty” pads by Nelson Electric.
   4. “Putty Pads” manufactured by Specified Technologies, Inc.
   5. “TREMstop MP” manufactured by Tremco, Inc.

D. Elsewhere (Acoustical Putty Pads): Provide one of the following, or equal.
   1. “Lowry Box Pads” manufactured by Henry A. Lowry Co.
   2. “Sound Pad #68” manufactured by LH Dottie Co.

2.5 INSTALLATION MATERIALS

A. Acoustical Insulation Hangers:
   1. Application: Used to attach acoustical insulation to clean, dry, smooth, non-porous solid surfaces.
   2. Manufacturer: Provide products manufactured by AGM Industries, Inc., or equal.
   3. Products: Provide the following, or equal.
      a. Anchors: “TACTOO Insul-Hangers” adhesively attached spindle-type anchors.
      b. Adhesive: “BOSS 348 Multi-Purpose Construction Adhesive” manufactured by Accumetric, LLC or other VOC-compliant acoustical insulation hanger adhesive.
      c. Acoustical insulation Standoff: One-inch “Clutch Clip”.
      d. Acoustical insulation Retaining Washers: “Style RC 200” round or “SC 250” square washers.
   4. Requisite Properties:
      a. Base Plate and Acoustical insulation Standoff and Retaining Washers: At least 2-inch square by at least 0.149-inch (MSG 28) base metal thickness galvanized perforated steel sheet.
      b. Retaining Washers: At least 1-1/2-inch square or diameter by at least 0.149-inch (MSG 28) base metal thickness galvanized perforated steel sheet.

c. Spindle: At least 0.106-inch diameter (SWG 12), zinc-coated wire, depth to suit depth of acoustical insulation indicated.
d. Adhesive: Adhesive used with impaling pins must either be manufactured or accepted by the acoustical insulation hanger manufacturer. “Peel and press” hangers with self-adhering adhesive backings are prohibited.

B. Mechanical Fasteners: Tape, staples, and other devices for fastening acoustical insulation supplied, required, recommended, or accepted by the acoustical insulation manufacturer.

C. Hanger Wire: At least 0.106-inch diameter (SWG 12) soft temper zinc-coated wire conforming to ASTM A 641, Class 3 or A coating.

D. Adhesive: Supplied, require, recommended, or accepted by the acoustical insulation manufacturer to bond acoustical insulation securely to substrates indicated without damaging acoustical insulation or substrates.

2.6 ACCESSORIES

A. Joint Backing:
1. Description: Extruded closed-cell polyethylene foam cylindrical sealant backings conforming to ASTM C 1330, Type C.
2. Products: Provide one of the following, or equal.
a. “Mile High Foam” manufactured by Backer Rod Mfg. Inc.
b. “HBR” or “Green Rod” manufactured by Nomaco, Inc.
c. “NuFlex 870” manufactured by TVM Building Products.
3. Performance Requirements:
a. Maximum Water Absorption: Not more than 0.10 grams per cubic centiliter when tested in conformance with conformance with ASTM C 1016, Procedure B.
b. Minimum Density: At least 24 per cubic meter when tested in conformance with conformance with ASTM D 1622.
c. Maximum Outgassing: Less than 1 bubble when tested in conformance with conformance with ASTM D 1253.
d. Minimum Compression Recovery: At least 90 percent, when tested in conformance with conformance with ASTM D 5249.
e. Minimum Compression Deflection: At least 20.5 percent, when tested in conformance with conformance with ASTM D 5249.
f. Minimum Tensile Strength: At least 200 kPa, when tested in conformance with conformance with ASTM D 1623.

B. Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification: Verify in-place supporting and adjacent construction conforms to the manufacturer's requirements or recommendations and satisfies all other conditions that might affect the quality of installation or the durability, appearance, or performance of installed and adjacent items.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.
   2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 INSTALLATION

A. General Requirements:
   1. Install acoustical insulation using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
   2. Extend acoustical insulation to envelop entire area insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
   3. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of acoustical insulation to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.
   4. Installed acoustical insulation must be warrantable. Do not install, correct, or replace acoustical insulation in a manner that results in any warranty or guarantee becoming void.

B. Special Techniques:
   1. Wall Insulation:
      a. Install acoustical insulation in cavities formed by framing members.
      b. Use acoustical insulation that fills the cavities. If more than one length is required to fill the cavities, then provide lengths that will produce a snug fit between ends.
      c. Place acoustical insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.

d. Maintain 3-inch clearance around recessed lighting fixtures not rated for or protected from contact with acoustical insulation.
e. Stuff loose-fill insulation into miscellaneous voids and cavity spaces where shown. Compact to roughly 40 percent of normal maximum volume.
f. For metal-framed wall cavities higher than 96 inches, support unfaced blankets mechanically and support faced blankets by taping insulation flanges to metal stud flanges.

2. Ceiling Insulation:
   a. Install blanket acoustical insulation above ceilings where indicated.
   b. Maintain 3-inch clearance of acoustical insulation around recessed lighting fixtures.
3. Acoustical Sealant Installation:
   a. At sound-rated assemblies and elsewhere indicated, seal construction in conformance with ASTM C 919 with a continuous bead of acoustical sealant at perimeter, behind control joints, and at openings and penetrations.
   b. Install acoustical sealant to both faces of partitions at perimeters and through penetrations.

C. Acoustical Installation Requirements:
1. Application: Apply acoustical sealant where shown on drawings and the following.
   a. Both sides and perimeter of door and window frames.
   b. Penetrations of partitions, floors, and ceilings by piping, ventilation ducts, conduits, cables, and cable trays.
   c. Perimeter and between joints of all sound isolating partitions, floors, and ceilings.
2. Acoustical Sealant:
   a. Use continuous beads of acoustical sealant along gypsum board face layer to seal assemblies at head, sill, perimeter, and penetrations, and joints between layers of sound isolating gypsum board construction and around the perimeter of resilient ceilings.
   b. Comply with ASTM C 919 requirements for use of joint sealants in acoustical applications as applicable to materials and conditions indicated.
3. Sheet Sealant:
   a. In fall full height, sound rated, and sound sensitive walls, over back and sides of all electrical, telephone, and communication boxes with specified acoustical pads.
   b. Verify unused knockouts are plugged before installing the pads. Mold pads tightly to the boxes and to the adjacent surfaces.
4. Installation:
   a. To seal gaps 3/8-inch in dimension and larger, pack with glass/mineral fiber batt prior to installing sealant materials.
   b. Use compressible closed-cell foam backer rod as required. Uncompressed backer rod width should be 30 to 50 percent greater than joint width.

D. Interface with Adjacent Items: Provide materials, components, and accessories normally furnished or necessary to securely attach acoustical insulation to supporting construction.

3.3 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
   1. written descriptions of non-conforming, damaged, and defective work;
   2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
   3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.4 CLEANING

A. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

3.5 PROTECTION

A. Protect installed acoustical insulation in place from becoming wet, deterioration, and damage until covering.

B. Do not store anything adjacent to or against installed acoustical insulation unless it is protected from damage, as accepted in writing by the manufacturer's representative. Do not use installed acoustical insulation as work surfaces.

C. Remove protection when it's no longer needed and before covering.

END OF SECTION

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SECTION 09 91 00 – PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Field-applied finish paint.
   2. Surface preparation.
   3. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

B. Related Requirements:
   1. Section 09 96 56 for epoxy coatings.

1.2 REFERENCES

A. Abbreviations and Acronyms:
   1. DFT: Dry Film Thickness.
   2. GU: Gloss Unit.
   3. SSPC: The Society for Protective Coatings.

B. Definitions:
   1. Manufacturer: Means the paint manufacturer, unless otherwise indicated.
   2. Paint: Means all applied materials, including fillers, primers, emulsions, enamels, varnishes, stains, lacquers, and sealers, whether used as a prime, intermediate, or finish coat.
   3. Coating: Means the same as paint.
   4. Coat: Means a layer of paint that is applied and then permitted to dry. Both back-rolling and applying wet-on-wet are one coat.
   5. Finish: Means an entire coating system, including all surface preparation methods, primers, coats, textures, colors, and sheens.
   6. Thickness: Means the total finish DFT, measured in conformance with SSPC paint application standard SSPC-PA2, "*Measurement of Dry Coating Thickness with Magnetic Gages*".
   7. Touchup: Means to correct or repair non-conforming or deficient areas to bring into conformance with the Contract Documents.
   8. Refinish: Means to apply a new finish to a previously-finished item or surface.
   9. Sheen: Means the following gloss ranges, when tested in conformance with ASTM D 523.

Sheen	Reference Description	Gloss Range	Test Method
Gloss Level 1 (Low Sheen)	Matte/Flat	1 to 5 GUs 1 to 10 GUs	60-degree meter 85-degree meter
Gloss Level 2 (Low Sheen)	Velvet	6 to 10 GUs 11 to 24 GUs	60-degree meter 85-degree meter
Gloss Level 3 (Medium Sheen)	Eggshell	11 to 20 GUs 25 to 35 GUs	60-degree meter 85-degree meter
Gloss Level 4 (Medium Sheen)	Satin	21 to 35 GUs >35 GUs	60-degree meter 85-degree meter
Gloss Level 5 (Medium Sheen)	Low sheen	36 to 49 GUs	60-degree meter
Gloss Level 6 (Medium Sheen)	Semi-gloss	50 to 70 GUs	60-degree meter
Gloss Level 7 (High Sheen)	Gloss	71 to 85 GUs Up to 60 GUs	60-degree meter 20-degree meter
Gloss Level 8 (High Sheen)	High-Gloss	>85 GUs >60 GUs	60-degree meter 20-degree meter

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Unless otherwise indicated, paint all surfaces throughout the Project, except the following.
      a. Concrete.
      b. Steel decking.
      c. Roofing.
      d. Insulation and its facing.
      e. Finish hardware, except items specified with a USP finish.
      f. Prefinished metal surfaces, including anodized aluminum, chrome plating, powder coatings, and similar pre-finished materials.
      g. Natural finish metal surfaces, including mill finish aluminum, stainless steel, copper, bronze, brass and similar finished materials.
      h. Walls or ceilings in concealed and inaccessible areas, including furred areas, chases, and shafts.
      i. Moving, mechanical, or electrical parts of operating units, including valve and damper operator linkages, sensing devices, motor and fan shafts..

j. Nameplates and required labels, including UL, FM, and other equipment identification, performance rating, or name plates.

2. Paint all visible surfaces, including surfaces visible through registers, screens and grilles whether or not colors are designated, except where a material's natural finish is obviously intended or explicitly indicated as a surface not painted.
3. Where surfaces are not specifically indicated, paint them to match adjacent similar materials or areas.
4. Specified surface preparation, priming, and paint coats are in addition to surface preparation and shop priming indicated in other specification sections.
5. Coordinate selected paint for compatibility with primers indicated in other specification sections.
   a. Provide prime coats that are compatible with subsequent coats or provide compatible barrier coats over incompatible primers; or completely remove primer and re-prime.
   b. Verify chemical and adhesive compatibility of all coats within each paint finish.
6. Coordinate selected paint for compatibility with chemicals used near or on painted surfaces, including cleaning materials, accessories, and methods.
7. Proposed substitution requests and submittals that change the quality (grade) or generic chemistry of specified paint are prohibited and returned to the Contractor without review or responsive action, except to record non-conformance with this requirement.
8. Specified coverage rates and thicknesses are minimum. If manufacturer's recommended coverage rates differ from specified rates, then
   a. consult the manufacturer's representative and obtain manufacturer-recommended coverage rates printed on manufacturer's letterhead;
   b. assume the manufacturer-recommended coverage rates govern; and
   c. promptly submit an RFI to the Architect for resolution; include manufacturer-recommended coverage rates with the RFI.
9. Master Painters Institute standards are insufficient for and not applicable to this project.

B. Sequencing:
1. Schedule paint deliveries to the project site only after the building is enclosed with a permanent enclosure; "wet work" within storage areas (including concrete, cast underlayment, mortaring, grouting, plastering, and gypsum board finishing) is complete and cured or dried to a condition of equilibrium; storage areas are broom- and vacuum-clean; and the HVAC system is activated, operating, and maintaining ambient conditions at occupancy levels.
2. Before beginning installation, final light fixtures must be completely installed, energized, and fully illuminated to at least the same type and level of illumination, and color temperature, maintained in the room or space after the building is occupied.
3. Install paint only after penetrating items are installed.

4. After paint installation, maintain ambient conditions within a range required, recommended, approved, or accepted by the manufacturer until Final Completion.

C. Scheduling:
1. Concrete Curing: Allow enough time in the construction schedule for concrete to cure for at least 28 days and dry before beginning surface preparation and installation.
2. Concrete Masonry Units: CMU walls must be painted within 30 days after building close-in.
3. Cleaning: Schedule cleaning to prevent dust and other contaminants from falling on freshly-applied paint.

1.4 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
1. Product Data: Submit manufacturer's product data, specifications, typical installation details, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs), and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
2. Paint Schedule:
a. Prepare a list of specified finishes and their project locations, with selected products identified for each coat of every finish.
b. Identify substrates to which each specified finish is applied, including surface preparation methods and primers for each substrate.
3. Samples: Submit 8-1/2-inch by 11-inch drawdown cards of each specified color and sheen. Label each card with project location.

B. Maintenance Material Submittals:
1. Before Final Completion, deliver to the Owner extra stock materials to replace those worn or damaged as a result of normal occupancy.
2. Furnish one unopened gallon or container for each paint type, color, composition, grade, finish, and variety.
3. Submit manufacturer-recommended cleaning materials, accessories, and manufacturer's instructions and other requirements and recommendations for maintenance and cleaning of painted surfaces, including a comprehensive list of known chemicals that should not come into contact with painted surfaces.

1.5 QUALITY ASSURANCE

A. Source Limitations:
1. Paint must be obtained through one source from the same manufacturer (to ensure compatibility and a uniform appearance).

a. Certain items may be obtained from more than one manufacturer, but only when used for separate installations.
b. Items provided for each different installation must be obtained from the same source and manufacturer.

2. Provide secondary materials, components, accessories and other items from sources required, recommended, or accepted by the primary manufacturer for actual in-service conditions applicable to the project.

B. Field Samples: Include *in-situ* mockups as part of the work of this specification section.
1. The Architect reviews field samples for conformance to the Contract Documents and approves or rejects them as the standard by which subsequent work is evaluated.
2. Revise field samples and repeat reviews, including arranging all revisions and paying all revision costs, until accepted in writing by the Architect. Final acceptance of paint is made from field samples.
3. After acceptance, promptly identify and protect field samples for reference until Substantial Completion.
4. Approved field samples may remain part of the work after being identified for future reference.

1.6 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
2. Reject items that are not transported, delivered, or protected in conformance with manufacturer-recommended transport, delivery, and receiving requirements.
3. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items indoors as shipped, upright in their original packaging or containers, within dry, well-ventilated, broom-cleaned and enclosed storage areas.
1. Furnish adequate dunnage and bracing during storage.
2. Prevent stored items from contacting the floor and from deterioration and damage.
3. Do not leave items uncovered where they might be exposed to weather or become wet; or exposed to heat or sudden changes in temperature or relative humidity; or other sources of deterioration and damage, including dust and other airborne contaminants.

C. Handling: Handle items in conformance with manufacturer's instructions and other requirements and recommendations, and in a manner that that prevents damage.
1. Avoid damage to packaging and containers, and contamination of contents.
2. Rotate inventory; do not use items the shelf life of which is expired.

D. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

1.7 PROJECT CONDITIONS

A. Ambient Conditions: Install paint only when ambient temperature, RH, and other environmental conditions fall within ranges required, recommended, or accepted by the manufacturer.

B. Existing Conditions:
   1. Surface Conditions: Surfaces receiving paint must be dry. Install paint only when substrate moisture content and surface temperature fall within ranges required, recommended, or accepted by the manufacturer.
   2. Ventilation: Maintain adequate ventilation during and after installation and curing, setting, or drying. Where natural ventilation is inadequate, use forced-air circulation or mechanical ventilation as necessary for the installations indicated.
   3. Illumination: Provide permanent lighting or illuminate work spaces to at least the same level occurring in the room or space after Final Completion.

C. Other Conditions: Do not apply paint where dust is generated, or liquids are sprayed; or when windy conditions exist that may cause paint to be blown onto vegetation or other unintended surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide products manufactured by one of the following, or equal.
   1. Vista Paint.
   2. Dunn Edwards.
   3. Benjamin Moore.

2.2 PAINT

A. Description: 100-percent premium grade (best grade) low- and no-VOC paints, unless otherwise indicated.

B. Products: Indicated in the Paint Products Schedule at the end of this specification section.

C. Requisite Properties:
   1. Colors: Indicated on the Drawings.
   2. Sheens: Provide the following, unless otherwise indicated.
      a. Ceilings: Not more than Gloss Level 3. (Eggshell)
      b. Trim: At least Gloss Level 6. (Gloss)
      c. Bathroom Walls: At least Gloss Level 5. (Semi-Gloss)
      d. Other Walls: At least Gloss Level 3. (Eggshell)

2.3 ACCESSORIES

A. Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

2.4 MIXING

A. Factory-mix paint to match approved samples and mockups accepted by the Architect.

B. Box paint at the project site or factory-batch to ensure uniform and consistent color. This requirement includes specified maintenance materials.

C. Open paint containers only as required for use and mix only in designated areas.

D. Thoroughly agitate and stir materials to a uniform and smooth consistency suitable for proper installation.

E. Do not reduce, alter, or introduce foreign materials into paint, except in conformance with manufacturer's instructions and other requirements and recommendations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification:
   1. Verify in-place construction, project conditions, and the work of other specification sections conform to the manufacturer's instructions and other requirements and recommendations.
   2. Verify substrates are dry and free of curing compounds, sealers, hardeners, and deleterious and other substances that might interfere with paint adhesion, appearance, or performance.
   3. Verify items penetrating paint are installed.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.
   2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 PREPARATION

A. Protection:
   1. Work Area Protection: Protect work areas from dust and other airborne contaminants during surface preparation and paint installation.
   2. Adjacent Material Protection: Protect adjacent surfaces against soiling and damage. Utilize drop cloths, shields, masking, barricades, and other items necessary to protect adjacent surfaces.
   3. Opening Protection: Close and protect drains and other openings and penetrations to prevent paint intrusion or migration of liquids.

B. Substrate Preparation: Prepare substrates as required, recommended, or accepted by the manufacturer without limitation; and in a manner that does not result in any warranty or guarantee becoming void.

3.3 INSTALLATION

A. General Requirements:
   1. Install paint using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
   2. Only install paint under conditions that ensure finishes are free from blemishes and defects.
   3. Provide smooth surfaces of uniform finish, color, appearance, and coverage. Painted surfaces with cloudiness, spotting, holidays, runs, or other imperfections are prohibited and are rejected as non-conforming work.
   4. Do not exceed the application rates recommended by the manufacturer.
   5. Completed work must match approved samples and mockups, as accepted by the Architect.
   6. Installed paint must be warrantable. Do not install, correct, or replace paint in a manner that results in any warranty or guarantee becoming void.

B. Special Techniques:
   1. Produce uniform finished surfaces without substrates, undercoats, marks, or stains showing through. Produce sharp and even lines and color breaks.
   2. Paint surfaces behind movable equipment and furniture the same as adjacent exposed surfaces. Paint surfaces behind permanently fixed equipment or furniture with prime coat only.
   3. Paint back sides of access panels, removable or hinged covers, and similar hinged items the same as exposed surfaces.

3.4 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
   1. written descriptions of non-conforming, damaged, and defective work;
   2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
   3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.5 CLEANING

A. Cleaning Work: Clean spills, stains, soiling, overspray, and fallout from adjacent surfaces.
   1. Use cleaning materials, equipment, and accessories supplied, and means, methods, techniques, and procedures required, recommended, or accepted by the manufacturer.
   2. Do not use cleaning materials or procedures known to change, or that might change, the appearance of exposed finishes or adjacent surfaces; or cause deterioration or damage to exposed finishes or adjacent surfaces.
   3. Protect adjacent surfaces not being cleaned from staining, deterioration, damage, or other detrimental effects caused by cleaning.
   4. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be cleaned to the Architect's acceptance.

B. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

3.6 PROTECTION

A. Protect installed paint in place from soiling, deterioration, and damage until Substantial Completion.

B. Do not store anything on, adjacent to, or against painted surfaces unless they are protected from damage, as accepted in writing by the manufacturer's representative. Do not use painted surfaces as work surfaces.

C. Remove protection when it's no longer needed and before Substantial Completion.

3.7 SCHEDULE

A. Paint products schedule begins on the next page.

END OF SECTION

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SUBSTRATE	NO. OF COATS	VISTA PAINT	DUNN-EDWARDS	BENJAMIN MOORE
EXTERIOR SURFACES - LOW VOC				
Concrete & CMU Substrates: As specified in Section 09 96 13 - Elastomeric Coatings				
Concrete & Brick Substrates: 100% Acrylic FLAT				
	1st Coat	4600 Uniprime II	ESPR00 Eff-Stop	023 Fresh Start Primer
	2nd Coat	2000 Duratone	EVSH10 Evershield Flat	400 Regal Select Flat
	3rd Coat	2000 Duratone	EVSH10 Evershield Flat	400 Regal Select Flat
CMU Substrates: 100% Acrylic FLAT				
	1st Coat	018 Acrylic Block Filler	SBPR00 Blockfill	M88 Latex Block Filler
	2nd Coat	2000 Duratone	EVSH10 Evershield Flat	400 Regal Select Flat
	3rd Coat	2000 Duratone	EVSH10 Evershield Flat	400 Regal Select Flat
CMU Substrates: 100% Acrylic ELASTOMERIC				
	1st Coat	4600 Uniprime II	ESPR00 Eff-Stop	023 Fresh Start Primer
	2nd Coat	500 Solotex	W370 Endurawall	056 Moorlastic
	3rd Coat	500 Solotex	W370 Endurawall	056 Moorlastic
Finished Wood Surfaces: 100% Acrylic FLAT				
	1st Coat	4200 Terminator II	EZPR00 EZ Prime Premium	0046 Hi-Hide All Purpose Primer
	2nd Coat	2000 Duratone	EVSH10 Evershield Flat	W105 Regal Select Flat
	3rd Coat	2000 Duratone	EVSH10 Evershield Flat	W105 Regal Select Flat
Finished Wood Surfaces: 100% Acrylic SEMI-GLOSS				
	1st Coat	4200 Terminator II	EZPR00 EZ Prime Premium	0046 Hi-Hide All Purpose Primer
	2nd Coat	7000 Acriglo Semi-Gloss	EVSH50 Evershield Semi Gloss	W096Regal Soft Gloss
	3rd Coat	7000 Acriglo Semi-Gloss	EVSH50 Evershield Semi Gloss	W096Regal Soft Gloss
Finished Wood Surfaces: 100% Acrylic GLOSS				
	1st Coat	4200 Terminator II	EZPR00 EZ Prime Premium	0046 Hi-Hide All Purpose Primer
	2nd Coat	8500 Carefree Gloss	EVSH60 Evershield Gloss	NA
	3rd Coat	8500 Carefree Gloss	EVSH60 Evershield Gloss	NA

SUBSTRATE	NO. OF COATS	VISTA PAINT	DUNN-EDWARDS	BENJAMIN MOORE
Finished Wood Surfaces: Semi-Transparent Stain				
	1st Coat	Olympic Maximum ST Stain	Okon WPT-3	0638 Arborcoat S/T Stain
	2nd Coat	Olympic Maximum ST Stain	Okon WPT-3	0638 Arborcoat S/T Stain
Iron, Steel, and Galvanized Steel Surfaces: Specified in Section 09 97 13 - High Performance Steel Coatings				
Iron & Steel Substrates: 100% Acrylic GLOSS				
	1st Coat	9600 Protec	BRPR00-1 Block Rust	M04 Acrylic Metal Primer
	2nd Coat	8500 Carefree Gloss	EVSH60 Evershield Gloss	N/A
	3rd Coat	8500 Carefree Gloss	EVSH60 Evershield Gloss	N/A
Iron & Steel Substrates: 100% Acrylic SEMI-GLOSS				
	1st Coat	9600 Protec	BRPR00-1 Block Rust	M04 Acrylic Metal Primer
	2nd Coat	7000 Acriglo Semi-Gloss	EVSH50 Evershield Semi Gloss	402 Regal Soft Gloss
	3rd Coat	7000 Acriglo Semi-Gloss	EVSH50 Evershield Semi Gloss	402 Regal Soft Gloss
Galvanized Steel & Aluminum Substrates: 100% Acrylic GLOSS **Aluminum Surfaces:** 100% Acrylic GLOSS				
	Pretreatment	Krud Kutter Metal Etch	ME01 Etch	Jasco Prep N Prime
	1st Coat	4800 Metal Pro Primer	GAPR00 Galv-Alum Premium	P04 Acrylic Metal Primer
	2nd Coat	8500 Carefree Gloss	EVSH60 Evershield Gloss	N/A
	3rd Coat	8500 Carefree Gloss	EVSH60 Evershield Gloss	N/A
Galvanized Steel & Aluminum Substrates: 100% Acrylic SEMI-GLOSS **Aluminum Surfaces:** 100% Acrylic SEMI-GLOSS				
	Pretreatment	Krud Kutter Metal Etch	ME01 Etch	Jasco Prep N Prime
	1st Coat	4800 Metal Pro Primer	GAPR00 Galv-Alum Premium	P04 Acrylic Metal Primer
	2nd Coat	7000 Acriglo Semi-Gloss	EVSH50 Evershield Semi Gloss	W096 Regal Soft Gloss
	3rd Coat	7000 Acriglo Semi-Gloss	EVSH50 Evershield Semi Gloss	W096 Regal Soft Gloss

SUBSTRATE	NO. OF COATS	VISTA PAINT	DUNN-EDWARDS	BENJAMIN MOORE
Zinc Alloy Surfaces: 100% Acrylic SEMI-GLOSS				
	Pretreatment	Krud Kutter Metal Etch	ME01 Etch	Jasco Prep N Prime
	1st Coat	4800 Metal Pro Primer	GAPR00 Galv-Alum Premium	P04 Acrylic Metal Primer
	2nd Coat	7000 Acriglo Semi-Gloss	EVSH50 Evershield Semi Gloss	W096 Regal Soft Gloss
	3rd Coat	7000 Acriglo Semi-Gloss	EVSH50 Evershield Semi Gloss	W096 Regal Soft Gloss
Fiber Cement Board Surfaces: 100% Acrylic FLAT				
	1st Coat	4600 Uniprime II	ESPR00 Eff-Stop	N023 Fresh Start Primer
	2nd Coat	2000 Duratone	EVSH10 Evershield Flat	W105 Regal Select Flat
	3rd Coat	2000 Duratone	EVSH10 Evershield Flat	W105 Regal Select Flat
Portland Cement Plaster (Stucco) Surfaces (Does not apply to Polymer-Modified Plaster Surfaces): Specified in Section 09 96 13 - Elastomeric Coatings				
Portland Cement Plaster (Stucco) Substrates (Does not apply to Polymer-Modified Plaster Surfaces): 100% Acrylic FLAT				
	1st Coat	4600 Uniprime II	ESPR00 Eff-Stop	023 Fresh Start Primer
	2nd Coat	2000 Duratone	EVSH10 Evershield Flat	400 Regal Select Flat
	3rd Coat	2000 Duratone	EVSH10 Evershield Flat	400 Regal Select Flat
Gypsum Soffit Board Surfaces: 100% Acrylic FLAT				
	1st Coat	4600 Uniprime II	Inter-Kote Premium IKPR00	N023 Fresh Start Primer
	2nd Coat	2000 Duratone	EVSH10 Evershield Flat	W105 Regal Select Flat
	3rd Coat	2000 Duratone	EVSH10 Evershield Flat	W105 Regal Select Flat
INTERIOR SURFACES - LOW VOC				
Concrete Surfaces: 100% Acrylic FLAT				
	1st Coat	4600 Uniprime II	ESPR00 Eff-Stop	N023 Fresh Start Primer
	2nd Coat	7100 Acriglo Flat	SSHL10 Spartashield Flat	547 Regal Select Flat
	3rd Coat	7100 Acriglo Flat	SSHL10 Spartashield Flat	547 Regal Select Flat

SUBSTRATE	NO. OF COATS	VISTA PAINT	DUNN-EDWARDS	BENJAMIN MOORE
Concrete Surfaces: 100% Acrylic EGGSHELL				
	1st Coat	4600 Uniprime II	ESPR00 Eff-Stop Premium	N023 Fresh Start Primer
	2nd Coat	7500 Acriglo Eggshell	SSHL30 Spartashield Eggshell	550 Regal Select Pearl
	3rd Coat	7500 Acriglo Eggshell	SSHL30 Spartashield Eggshell	550 Regal Select Pearl
Concrete Surfaces: 100% Acrylic SEMI-GLOSS				
	1st Coat	4600 Uniprime II	ESPR00 Eff-Stop Premium	N023 Fresh Start Primer
	2nd Coat	7000 Acriglo Semi-Gloss	SSHL50 Spartashield Semi-Gloss	551 Regal Select Semi Gloss
	3rd Coat	7000 Acriglo Semi-Gloss	SSHL50 Spartashield Semi-Gloss	551 Regal Select Semi Gloss
Concrete Surfaces: 100% Acrylic GLOSS				
	1st Coat	4600 Uniprime II	ESPR00 Eff-Stop Premium	N023 Fresh Start Primer
	2nd Coat	8500 Carefree Gloss	EVSH 60 Evershield Gloss	794 Advance High Gloss
	3rd Coat	8500 Carefree Gloss	EVSH 60 Evershield Gloss	794 Advance High Gloss
Concrete Surfaces: 100% Epoxy GLOSS				
	1st Coat	4600 Uniprime II	Rust Oleum Sierra S70/S71 WB	N023 Fresh Start Primer
	2nd Coat	Rust-Oleum Sierra S60 Gloss WB Epoxy	Rust-Oleum Sierra S60 Gloss WB Epoxy	P43 Super Spec HP Gloss Epoxy
CMU Surfaces: 100% Acrylic Flat				
	1st Coat	018 Acrylic Block Filler	SBPR00 Blockfill	160 Latex Block Filler
	2nd Coat	7100 Acriglo Flat	SSHL10 Spartashield Flat	547 Regal Select Flat
	3rd Coat	7100 Acriglo Flat	SSHL10 Spartashield Flat	547 Regal Select Flat
CMU Surfaces: 100% Acrylic EGGSHELL				
	1st Coat	018 Acrylic Block Filler	SBPR00 Blockfill	160 Latex Block Filler
	2nd Coat	7500 Acriglo Eggshell	SSHL30 Spartashield Eggshell	550 Regal Select Pearl
	3rd Coat	7500 Acriglo Eggshell	SSHL30 Spartashield Eggshell	550 Regal Select Pearl

SUBSTRATE	NO. OF COATS	VISTA PAINT	DUNN-EDWARDS	BENJAMIN MOORE
CMU Surfaces: 100% Acrylic SEMI-GLOSS				
	1st Coat	018 Acrylic Block Filler	SBPR00 Blockfill	160 Latex Block Filler
	2nd Coat	7000 Acriglo Semi-Gloss	SSHL50 Spartashield Semi-Gloss	551 Regal Select Semi Gloss
	3rd Coat	7000 Acriglo Semi-Gloss	SSHL50 Spartashield Semi-Gloss	551 Regal Select Semi Gloss
CMU Surfaces: 100% Acrylic GLOSS				
	1st Coat	040 Block Kote	SBPR00 Blockfill	160 Latex Block Filler
	2nd Coat	8500 Carefree Gloss	EVSH 60 Evershield Gloss	794 Advance High Gloss
	3rd Coat	8500 Carefree Gloss	EVSH 60 Evershield Gloss	794 Advance High Gloss
CMU Surfaces: 100% Epoxy GLOSS				
	1st Coat	040 Block Kote	SBPR00 Blockfill	160 Latex Block Filler
	2nd Coat	Rust-Oleum Sierra S60 Gloss WB Epoxy	Rust-Oleum Sierra S60 Gloss WB Epoxy	P43 Super Spec HP Gloss Epoxy
Ferrous Metal Surfaces: 100% Acrylic SEMI-GLOSS				
	1st Coat	9600 Protec	BRPR00 Bloc-Rust	P04 Acrylic Metal Primer
	2nd Coat	7000 Acriglo Semi-Gloss	SSHL50 Spartashield Semi-Gloss	551 Regal Select Semi Gloss
	3rd Coat	7000 Acriglo Semi-Gloss	SSHL50 Spartashield Semi-Gloss	551 Regal Select Semi Gloss
Ferrous Metal Surfaces: 100% Acrylic GLOSS				
	1st Coat	9600 Protec	UGPR00 Ultra-Grip	P04 Acrylic Metal Primer
	2nd Coat	8500 Carefree Gloss	EVSH 60 Evershield Gloss	794 Advance High Gloss
	3rd Coat	8500 Carefree Gloss	EVSH 60 Evershield Gloss	794 Advance High Gloss
Aluminum Surfaces: 100% Acrylic SEMI-GLOSS				
	1st Coat	9600 Protec	BRPR00 Bloc-Rust	P04 Acrylic Metal Primer
	2nd Coat	7000 Acriglo Semi-Gloss	SSHL50 Spartashield Semi-Gloss	551 Regal Select Semi Gloss
	3rd Coat	7000 Acriglo Semi-Gloss	SSHL50 Spartashield Semi-Gloss	551 Regal Select Semi Gloss

SUBSTRATE	NO. OF COATS	VISTA PAINT	DUNN-EDWARDS	BENJAMIN MOORE
Aluminum Surfaces: 100% Acrylic GLOSS				
	1st Coat	9600 Protec	UGPR00 Ultra-Grip	P04 Acrylic Metal Primer
	2nd Coat	8500 Carefree Gloss	EVSH 60 Evershield Gloss	794 Advance High Gloss
	3rd Coat	8500 Carefree Gloss	EVSH 60 Evershield Gloss	794 Advance High Gloss
Stainless Steel, Copper, and Brass Surfaces: 100% Acrylic SEMI-GLOSS				
	1st Coat	9600 Protec	BRPR00 Bloc-Rust	P04 Acrylic Metal Primer
	2nd Coat	7000 Acriglo Semi-Gloss	SSHL50 Spartashield Semi-Gloss	551 Regal Select Semi Gloss
	3rd Coat	7000 Acriglo Semi-Gloss	SSHL50 Spartashield Semi-Gloss	551 Regal Select Semi Gloss
Stainless Steel, Copper, and Brass Surfaces: 100% Acrylic GLOSS				
	1st Coat	9600 Protec	UGPR00 Ultra-Grip	P04 Acrylic Metal Primer
	2nd Coat	8500 Carefree Gloss	EVSH 60 Evershield Gloss	794 Advance High Gloss
	3rd Coat	8500 Carefree Gloss	EVSH 60 Evershield Gloss	794 Advance High Gloss
Rough Sawn Wood Surfaces: Semi-Transparent Stain				
	1st Coat	Olympic S/T Stain	Okon WPT-3	0638 Arborcoat S/T Stain
	2nd Coat	Olympic S/T Stain	Okon WPT-3	0638 Arborcoat S/T Stain
Finished Wood Surfaces: Semi-Transparent Stain				
	1st Coat	VWS0250 Series ST Stain	Old Masters Wood Stain	Moore's S/T WB Stain
Finished Wood Surfaces: Clear Lacquer Finish				
	1st Coat	NRS 1620 Sanding Sealer	LQX 101-0 Sanding Sealer	NRS 1620 Sanding Sealer
	2nd Coat	NRF 1626 Satin Lacquer	LQX 104-0 Satin Lacquer	NRF 1626 Satin Lacquer
	3rd Coat	NRF 1626 Satin Lacquer	LQX 103-0 Satin Lacquer	NRF 1626 Satin Lacquer
Finished Wood Surfaces: Water White Finish (for light-colored stains)				
	1st Coat	NAF 1420 Satin Sealer	LQX 131-0 Sanding Sealer	NAF 1420 Satin Sealer
	2nd Coat	NAF 1422 Satin Lacquer	LQX 132-0 Satin Lacquer	NAF 1426 Satin Lacquer
	3rd Coat	NAF 1422 Satin Lacquer	LQX 132-0 Satin Lacquer	NAF 1426 Satin Lacquer

SUBSTRATE	NO. OF COATS	VISTA PAINT	DUNN-EDWARDS	BENJAMIN MOORE
Finished Wood Surfaces: Clear Varnish Finish FLAT				
	1st Coat	Zenith PKF7501 Flat	Zenith PKF7501 Flat	Zenith PKF7501 Flat
	2nd Coat	Zenith PKF7501 Flat	Zenith PKF7501 Flat	Zenith PKF7501 Flat
	3rd Coat	Zenith PKF7501 Flat	Zenith PKF7501 Flat	Zenith PKF7501 Flat
Finished Wood Surfaces: Clear Varnish Finish SEMI-GLOSS				
	1st Coat	Zenith PKF7501 Flat	Zenith PKF7502 Satin	Zenith PKF7502 Satin
	2nd Coat	Zenith PKF7501 Flat	Zenith PKF7502 Satin	Zenith PKF7502 Satin
	3rd Coat	Zenith PKF7501 Flat	Zenith PKF7502 Satin	Zenith PKF7502 Satin
Finished Wood Surfaces: Clear Varnish Finish GLOSS				
	1st Coat	Zenith PKC7509 Gloss	Zenith PKC7509 Gloss	Zenith PKC7509 Gloss
	2nd Coat	Zenith PKC7509 Gloss	Zenith PKC7509 Gloss	Zenith PKC7509 Gloss
	3rd Coat	Zenith PKC7509 Gloss	Zenith PKC7509 Gloss	Zenith PKC7509 Gloss
Finished Wood Surfaces: 100% Acrylic LOW SHEEN				
	1st Coat	4200 Terminator II	UGPR00 Ultra-Grip	0046 Hi-Hide All Purpose Primer
	2nd Coat	1750 Acriglo Low Sheen	SPMA20 Suprema VS	549 Regal Select Eggshell
	3rd Coat	1750 Acriglo Low Sheen	SPMA20 Suprema VS	549 Regal Select Eggshell
Finished Wood Surfaces: 100% Acrylic SEMI-GLOSS				
	1st Coat	4200 Terminator II	UGPR00 Ultra-Grip	0046 Hi-Hide All Purpose Primer
	2nd Coat	7000 Acriglo Semi-Gloss	SPMA50 Suprema Semi Gloss	551 Regal Select Semi Gloss
	3rd Coat	7000 Acriglo Semi-Gloss	SPMA50 Suprema Semi Gloss	551 Regal Select Semi Gloss
Finished Wood Surfaces: 100% Acrylic Dryfall FLAT				
	1st Coat	DF 12 Dryfall Flat	W 6079 Aquafall Flat	M53 Dryfall Flat
	2nd Coat	DF 12 Dryfall Flat	W 6079 Aquafall Flat	M53 Dryfall Flat
Particle Board, MDF, and Hardboard Surfaces: 100% Acrylic FLAT				
	1st Coat	4000 Uniprime II	UGPR00 Ultra-Grip	N023 Fresh Start Primer
	2nd Coat	7100 Acriglo Flat	SPMA10 Suprema Flat	547 Regal Select Flat
	3rd Coat	7100 Acriglo Flat	SPMA10 Suprema Flat	547 Regal Select Flat

SUBSTRATE	NO. OF COATS	VISTA PAINT	DUNN-EDWARDS	BENJAMIN MOORE
Particle Board, MDF, and Hardboard Surfaces: 100% Acrylic SEMI-GLOSS				
	1st Coat	4000 Uniprime II	UGPR00 Ultra-Grip	N023 Fresh Start Primer
	2nd Coat	7000 Acriglo Semi-Gloss	SPMA50 Suprema Semi Gloss	551 Regal Select Semi Gloss
	3rd Coat	7000 Acriglo Semi-Gloss	SPMA50 Suprema Semi Gloss	551 Regal Select Semi Gloss
Particle Board, MDF, and Hardboard Surfaces: 100% Acrylic GLOSS				
	1st Coat	4000 Uniprime II	UGPR00 Ultra-Grip	N023 Fresh Start Primer
	2nd Coat	8500 Carefree Gloss	EVSH 60 Evershield Gloss	794 Advance High Gloss
	3rd Coat	8500 Carefree Gloss	EVSH 60 Evershield Gloss	794 Advance High Gloss
Portland Cement Plaster Surfaces: 100% Acrylic FLAT				
	1st Coat	4600 Uniprime II	ESPR00 Eff-Stop Premium	N023 Fresh Start Primer
	2nd Coat	7100 Acriglo Flat	SPMA10 Suprema Flat	547 Regal Select Flat
	3rd Coat	7100 Acriglo Flat	SPMA10 Suprema Flat	547 Regal Select Flat
Portland Cement Plaster Surfaces: 100% Acrylic EGGSHELL				
	1st Coat	4600 Uniprime II	ESPR00 Eff-Stop Premium	N023 Fresh Start Primer
	2nd Coat	7500 Acriglo Eggshell	SPMA30 Suprema LS	550 Regal Select Pearl
	3rd Coat	7500 Acriglo Eggshell	SPMA30 Suprema LS	550 Regal Select Pearl

SUBSTRATE	NO. OF COATS	VISTA PAINT	DUNN-EDWARDS	BENJAMIN MOORE
Portland Cement Plaster Surfaces: 100% Acrylic SEMI-GLOSS				
	1st Coat	4600 Uniprime II	ESPR00 Eff-Stop Premium	N023 Fresh Start Primer
	2nd Coat	7000 Acriglo Semi-Gloss	SPMA50 Suprema Semi Gloss	551 Regal Select Semi Gloss
	3rd Coat	7000 Acriglo Semi-Gloss	SPMA50 Suprema Semi Gloss	551 Regal Select Semi Gloss
Portland Cement Plaster Surfaces: 100% Acrylic GLOSS				
	1st Coat	4600 Uniprime II	ESPR00 Eff-Stop Premium	N023 Fresh Start Primer
	2nd Coat	8500 Carefree Gloss	EVSH 60 Evershield Gloss	794 Advance High Gloss
	3rd Coat	8500 Carefree Gloss	EVSH 60 Evershield Gloss	794 Advance High Gloss
Portland Cement Plaster Surfaces: 100% Epoxy GLOSS				
	1st Coat	4600 Uniprime II	Rust-Oleum S70/S71 WB	N023 Fresh Start Primer
	2nd Coat	Rust-Oleum Sierra S60 Gloss WB Epoxy	Rust-Oleum Sierra S60 Gloss WB Epoxy	P43 Super Spec HP Gloss Epoxy
Gypsum Board Surfaces: 100% Acrylic FLAT				
	1st Coat	N/A	VNPR00 Vinylastic Premium	NA
	2nd Coat	7100 Acriglo Flat	SPMA10 Suprema Flat	547 Regal Select Flat
	3rd Coat	7100 Acriglo Flat	SPMA10 Suprema Flat	547 Regal Select Flat
Gypsum Board Surfaces: 100% Acrylic LOW SHEEN				
	1st Coat	5001 Vpro Primer	VNPR00 Vinylastic Premium	N023 Fresh Start Primer
	2nd Coat	5200 Vpro Low Sheen	SPMA20 Suprema VS	549 Regal Select Eggshell
	3rd Coat	5200 Vpro Low Sheen	SPMA20 Suprema VS	549 Regal Select Eggshell
Gypsum Board Surfaces: 100% Acrylic EGGSHELL				
	1st Coat	5001 Vpro Primer	VNPR00 Vinylastic Premium	N023 Fresh Start Primer
	2nd Coat	5300 Vpro Eggshell	SPMA30 Suprema LS	550 Regal Select Pearl
	3rd Coat	5300 Vpro Eggshell	SPMA30 Suprema LS	550 Regal Select Pearl

SUBSTRATE	NO. OF COATS	VISTA PAINT	DUNN-EDWARDS	BENJAMIN MOORE
Gypsum Board Surfaces: 100% Acrylic SEMI-GLOSS				
	1st Coat	5001 Vpro Primer	VNPR00 Vinylastic Premium	N023 Fresh Start Primer
	2nd Coat	5400 Vpro Semi-Gloss	SPMA50 Suprema Semi Gloss	551 Regal Select Semi Gloss
	3rd Coat	5400 Vpro Semi-Gloss	SPMA50 Suprema Semi Gloss	551 Regal Select Semi Gloss
Gypsum Board Surfaces: 100% Acrylic GLOSS				
	1st Coat	5001 Vpro Primer	VNPR00 Vinylastic Premium	N023 Fresh Start Primer
	2nd Coat	8500 Carefree Gloss	EVSH 60 Evershield Gloss	794 Advance High Gloss
	3rd Coat	8501 Carefree Gloss	EVSH 60 Evershield Gloss	794 Advance High Gloss
Gypsum Board Surfaces: 100% Epoxy GLOSS				
	1st Coat	5001 Vpro Primer	Rust-Oleum Sierra S70/S71 WB Epoxy Acrylic Primer	N/A
	2nd Coat	Rust-Oleum Sierra S60 Gloss WB Epoxy	Rust-Oleum Sierra S60 Gloss WB Epoxy	N/A
Acoustical Tile Surfaces: 100% Acrylic FLAT				
	1st Coat	013 Acoustic Kote	W 615 Acoustikote	258 Moore's Ceiling White
	2nd Coat	013 Acoustic Kote	W 615 Acoustikote	258 Moore's Ceiling White
INTERIOR SURFACES - ZERO VOC				
Concrete Surfaces: Acrylic FLAT				
	1st Coat	5001 Vpro Primer	VNSL00 Vinylastic Select Primer	511 Natura Primer
	2nd Coat	5100 Vpro Flat	EVER 10 Everest Flat	512 Natura Flat
	3rd Coat	5100 Vpro Flat	EVER 10 Everest Flat	512 Natura Flat
Concrete Surfaces: 100% Acrylic EGGSHELL				
	1st Coat	5001 Vpro Primer	VNSL00 Vinylastic Select Primer	511 Natura Primer
	2nd Coat	5300 Vpro Eggshell	EVER 30 Everest Eggshell	513 Natura Eggshell
	3rd Coat	5300 Vpro Eggshell	EVER 30 Everest Eggshell	513 Natura Eggshell

SUBSTRATE	NO. OF COATS	VISTA PAINT	DUNN-EDWARDS	BENJAMIN MOORE
Concrete Surfaces: 100% Acrylic SEMI-GLOSS				
	1st Coat	5001 Vpro Primer	VNSL00 Vinylastic Select Primer	511 Natura Primer
	2nd Coat	5400 Vpro Semi-Gloss	EVER 50 Everest Semi Gloss	514 Natura Semi Gloss
	3rd Coat	5400 Vpro Semi-Gloss	EVER 50 Everest Semi Gloss	514 Natura Semi Gloss
CMU Surfaces: Acrylic FLAT				
	1st Coat	040 Block Kote	SBPR00 Blockfill	160 Latex Block Filler
	2nd Coat	5100 Vpro Flat	EVER 10 Everest Flat	512 Natura Flat
	3rd Coat	5100 Vpro Flat	EVER 10 Everest Flat	512 Natura Flat
CMU Surfaces: 100% Acrylic EGGSHELL				
	1st Coat	040 Block Kote	SBPR00 Blockfill	160 Latex Block Filler
	2nd Coat	5300 Vpro Eggshell	EVER 30 Everest Eggshell	513 Natura Eggshell
	3rd Coat	5300 Vpro Eggshell	EVER 30 Everest Eggshell	513 Natura Eggshell
CMU Surfaces: 100% Acrylic SEMI-GLOSS				
	1st Coat	040 Block Kote	SBPR00 Blockfill	160 Latex Block Filler
	2nd Coat	5400 Vpro Semi-Gloss	EVER 50 Everest Semi Gloss	514 Natura Semi Gloss
	3rd Coat	5400 Vpro Semi-Gloss	EVER 50 Everest Semi Gloss	514 Natura Semi Gloss
Iron & Steel Surfaces: 100% Acrylic SEMI-GLOSS				
	1st Coat	9600 Protec	UGPR00 Ultra-Grip	P04 Acrylic Metal Primer
	2nd Coat	5400 Vpro Semi-Gloss	EVER 50 Everest Semi Gloss	514 Natura Semi Gloss
	3rd Coat	5400 Vpro Semi-Gloss	EVER 50 Everest Semi Gloss	514 Natura Semi Gloss

SUBSTRATE	NO. OF COATS	VISTA PAINT	DUNN-EDWARDS	BENJAMIN MOORE
Aluminum Surfaces: 100% Acrylic SEMI-GLOSS				
	1st Coat	4800 Metal Pro Primer	UGPR00 Ultra-Grip	P04 Acrylic Metal Primer
	2nd Coat	5400 Vpro Semi-Gloss	EVER 50 Everest Semi Gloss	514 Natura Semi Gloss
	3rd Coat	5400 Vpro Semi-Gloss	EVER 50 Everest Semi Gloss	514 Natura Semi Gloss
Stainless Steel, Copper, and Brass Surfaces: 100% Acrylic SEMI-GLOSS				
	1st Coat	4800 Metal Pro Primer	UGPR00 Ultra-Grip	P04 Acrylic Metal Primer
	2nd Coat	5400 Vpro Semi-Gloss	EVER 50 Everest Semi Gloss	514 Natura Semi Gloss
	3rd Coat	5400 Vpro Semi-Gloss	EVER 50 Everest Semi Gloss	514 Natura Semi Gloss
Finished Wood Surfaces: 100% Acrylic EGGSHELL				
	1st Coat	5001 Vpro Primer	UGPR00 Ultra-Grip	511 Natura Primer
	2nd Coat	5300 Vpro Eggshell	EVER 30 Everest Eggshell	513 Natura Eggshell
	3rd Coat	5300 Vpro Eggshell	EVER 30 Everest Eggshell	513 Natura Eggshell
Finished Wood Surfaces: 100% Acrylic SEMI-GLOSS				
	1st Coat	5001 Vpro Primer	UGPR00 Ultra-Grip	511 Natura Primer
	2nd Coat	5400 Vpro Semi-Gloss	EVER 50 Everest Semi Gloss	514 Natura Semi Gloss
	3rd Coat	5400 Vpro Semi-Gloss	EVER 50 Everest Semi Gloss	514 Natura Semi Gloss
Particle Board, MDF, and Hardboard Surfaces: Acrylic FLAT				
	1st Coat	5001 Vpro Primer	UGPR00 Ultra-Grip	511 Natura Primer
	2nd Coat	5100 Vpro Flat	EVER 10 Everest Flat	512 Natura Flat
	3rd Coat	5100 Vpro Flat	EVER 10 Everest Flat	512 Natura Flat

SUBSTRATE	NO. OF COATS	VISTA PAINT	DUNN-EDWARDS	BENJAMIN MOORE
Particle Board, MDF, and Hardboard Surfaces: 100% Acrylic SEMI-GLOSS				
	1st Coat	5001 Vpro Primer	UGPR00 Ultra-Grip	511 Natura Primer
	2nd Coat	5400 Vpro Semi-Gloss	EVER 50 Everest Semi Gloss	514 Natura Semi Gloss
	3rd Coat	5400 Vpro Semi-Gloss	EVER 50 Everest Semi Gloss	514 Natura Semi Gloss
Portland Cement Plaster Surfaces: Acrylic FLAT				
	1st Coat	5001 Vpro Primer	VNSL00 Vinylastic Select Primer	511 Natura Primer
	2nd Coat	5100 Vpro Flat	EVER 10 Everest Flat	512 Natura Flat
	3rd Coat	5100 Vpro Flat	EVER 10 Everest Flat	512 Natura Flat
Portland Cement Plaster Surfaces: 100% Acrylic EGGSHELL				
	1st Coat	5001 Vpro Primer	VNSL00 Vinylastic Select Primer	511 Natura Primer
	2nd Coat	5300 Vpro Eggshell	EVER 30 Everest Eggshell	513 Natura Eggshell
	3rd Coat	5300 Vpro Eggshell	EVER 30 Everest Eggshell	513 Natura Eggshell
Portland Cement Plaster Surfaces: 100% Acrylic SEMI-GLOSS				
	1st Coat	5001 Vpro Primer	VNSL00 Vinylastic Select Primer	511 Natura Primer
	2nd Coat	5400 Vpro Semi-Gloss	EVER 50 Everest Semi Gloss	514 Natura Semi Gloss
	3rd Coat	5400 Vpro Semi-Gloss	EVER 50 Everest Semi Gloss	514 Natura Semi Gloss

SUBSTRATE	NO. OF COATS	VISTA PAINT	DUNN-EDWARDS	BENJAMIN MOORE
Gypsum Board Surfaces: Acrylic FLAT				
	1st Coat	Not Required	VNSL00 Vinylastic Select Primer	511 Natura Primer
	2nd Coat	5100 Vpro Flat	EVER 10 Everest Flat	512 Natura Flat
	3rd Coat	5100 Vpro Flat	EVER 10 Everest Flat	512 Natura Flat
Gypsum Board Surfaces: 100% Acrylic EGGSHELL				
	1st Coat	5001 Vpro Primer	VNSL00 Vinylastic Select Primer	511 Natura Primer
	2nd Coat	5300 Vpro Eggshell	EVER 30 Everest Eggshell	513 Natura Eggshell
	3rd Coat	5300 Vpro Eggshell	EVER 30 Everest Eggshell	513 Natura Eggshell
Gypsum Board Surfaces: 100% Acrylic SEMI-GLOSS				
	1st Coat	5001 Vpro Primer	VNSL00 Vinylastic Select Primer	511 Natura Primer
	2nd Coat	5400 Vpro Semi-Gloss	EVER 50 Everest Semi Gloss	514 Natura Semi Gloss
	3rd Coat	5400 Vpro Semi-Gloss	EVER 50 Everest Semi Gloss	514 Natura Semi Gloss
Acoustical Tile Surfaces: Acrylic FLAT				
	1st Coat	5100 Vpro Flat	EVER 10 Everest Flat	512 Natura Flat
	2nd Coat	5100 Vpro Flat	EVER 10 Everest Flat	512 Natura Flat

SECTION 09 97 23 – PENETRATING CONCRETE FLOOR SEALER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Penetrating concrete floor sealer.
   2. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

1.2 REFERENCES

A. Definitions:
   1. Manufacturer: Means the concrete sealer manufacturer, unless otherwise indicated.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Verify chemical and adhesive compatibility of selected concrete sealer with installed curing compounds and installed moisture vapor emission control systems, based on current product formulations.
   2. Coordinate selected sealer for compatibility with chemicals used near or on coated surfaces, including cleaning materials, accessories, and methods.
   3. Proposed substitution requests and submittals that change the quality (grade) or generic chemistry of specified concrete sealers are prohibited and returned to the Contractor without review or responsive action, except to record non-conformance with this requirement.
   4. Specified coverage rates and thicknesses are minimum. If manufacturer's recommended coverage rates differ from specified rates, then
      a. consult the manufacturer's representative and obtain manufacturer-recommended coverage rates printed on manufacturer's letterhead;
      b. assume the manufacturer-recommended coverage rates govern; and
      c. promptly submit an RFI to the Architect for resolution; include manufacturer-recommended coverage rates with the RFI.

B. Sequencing:
   1. Install concrete sealers only after concrete is cured to a condition of equilibrium; is sufficiently dry to bond with concrete sealers; and has alkalinity (pH), MVER, and RH within ranges required, recommended, or accepted by the manufacturer.

2. Either delay concrete sealer installation until after joint sealant installation is complete, or protect sealant bond surfaces to prevent concrete sealer migration onto joint surfaces. concrete sealer application may only precede sealant application after sealant adhesion and compatibility are tested and verified using substrates, concrete sealers, and sealant materials identical to those used in the work.

C. Scheduling: Allow enough time in the construction schedule for concrete to cure for at least 28 days before beginning surface preparation and installation.

1.4 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data: Submit manufacturer's product data, specifications, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs), and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.

B. Informational Submittals: Submit the following for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
   1. Manufacturer's Instructions: Submit manufacturer-prepared published instructions for proper installation of furnished concrete sealers.
      a. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.
      b. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.
   2. Qualification Statements: Submit written descriptions confirming experience specified in QUALITY ASSURANCE article below.

C. Maintenance Material Submittals:
   1. Before Final Completion, deliver to the Owner extra stock materials to replace those worn or damaged as a result of normal occupancy.
   2. Furnish one unopened gallon or container for each concrete sealer type, color, composition, grade, finish, and variety.
   3. Submit manufacturer-recommended cleaning materials, accessories, and manufacturer's instructions and other requirements and recommendations for maintenance and cleaning of sealed surfaces, including a comprehensive list of known chemicals that should not come into contact with sealed surfaces.

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Installer: Company or individuals must have at least 5 years' experience installing concrete sealers for at least 30 previous projects similar to this project in size, material, design, and complexity.
2. Supervisors: Individuals must have at least 7 years' experience installing concrete sealers for at least 30 previous projects similar to this project in size, material, design, and complexity, including at least 2 years' supervisory experience directing and leading concrete sealer installers.

1.6 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
   1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
   2. Reject items that are not transported, delivered, or protected in conformance with manufacturer-recommended transport, delivery, and receiving requirements.
   3. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items indoors as shipped, upright in their original packaging or containers, within dry, well-ventilated, broom-cleaned and enclosed storage areas.
   1. Furnish adequate dunnage and bracing during storage.
   2. Prevent stored items from contacting the floor and from deterioration and damage.
   3. Do not leave items uncovered where they might be exposed to weather or become wet; or exposed to heat or sudden changes in temperature or relative humidity; or other sources of deterioration and damage, including dust and other airborne contaminants.

C. Handling: Handle items in conformance with manufacturer's instructions and other requirements and recommendations, and in a manner that that prevents damage.
   1. Avoid damage to packaging and containers, and contamination of contents.
   2. Rotate inventory; do not use items the shelf life of which is expired.

D. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective concrete sealers with undamaged new concrete sealers that do not exhibit deterioration, damage, or defects.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

1.7 PROJECT CONDITIONS

A. Ambient Conditions: Install concrete sealers only when ambient temperature, RH, and other environmental conditions fall within ranges required, recommended, or accepted by the manufacturer.
   1. Do not install concrete sealers during rain or snow, fog or mist; or when rain or snow is predicted within 24 hours of installation.

2. Proceed only when there is no threat of impending precipitation, and both current and forecasted weather conditions conform to those required, recommended, or accepted by the manufacturer.
3. Do not apply concrete sealers when
   a. ambient temperature is below 45 deg. F or more than 90 deg. F during application, and for at least 8 hours after;
   b. surface temperatures are less than 40 deg. F or greater than 120 deg. F; and
   c. surface temperatures are 5 deg. F or less above the dew point.

B. Existing Conditions:
1. Surface Conditions: Surfaces receiving concrete sealers must be dry. Install concrete sealers only when substrate moisture content and surface temperature fall within ranges required, recommended, or accepted by the manufacturer.
2. Other Conditions: Do not apply concrete sealers where dust is generated, or liquids are sprayed; or when windy conditions exist that may cause concrete sealers to be blown onto vegetation or other unintended surfaces.

PART 2 - PRODUCTS

2.1 PENETRATING CONCRETE FLOOR SEALER

A. Description: Clear-drying, water-based silane or siloxane water repellent sealer for interior exposed concrete slabs.

B. Product: “Sure Klean Weather Seal Siloxane WB Concentrate” manufactured by PROSOCO, Inc., or equal.
1. Porous Surfaces (e.g., Concrete Brick, Concrete Pavers, and Concrete Tile): Dilute to 1 part concentrate to not more than 7 parts water.
2. Semi-Porous Surfaces (e.g., Cast-in-Place Concrete, Precast Concrete, Clay Brick, Terra Cotta, and Unpolished Sandstone): Dilute to 1 part concentrate to not more than 9 parts water.
3. Dense Surfaces: Dilute to 1 part concentrate to not more than 14 parts water.

C. Requisite Properties: When compared visually to an untreated sample under the same lighting conditions, concrete sealers may not alter the color or sheen of the coated substrate and must be invisible after application and over the life of the substrate. Confirm visual appearance by mockups and adjust products and applications as required.

2.2 ACCESSORIES

A. Mix Water: Provide fresh, clean, clear, potable water from a domestic source. Water must conform to ASTM C 1602 and be free of oil, grease, waxy films, curing compounds, release agents, and other deleterious materials, including salts, acids, alkalis, organic

materials, detergents, and other matter that might negatively affect tile quality, durability, or performance.

B. Other Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

2.3 MIXING

A. Open concrete sealer containers only as required for use and mix only in designated areas.

B. Thoroughly agitate and stir materials to a uniform and smooth consistency suitable for proper installation.

C. Do not reduce, alter, or introduce foreign materials into concrete sealers, except in conformance with manufacturer's instructions and other requirements and recommendations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification:
   1. Verify in-place construction, project conditions, and the work of other specification sections conform to the manufacturer's instructions and other requirements and recommendations.
   2. Verify substrates are dry and free of curing compounds, sealers, hardeners, and deleterious and other substances that might interfere with concrete sealer adhesion, appearance, or performance.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.
   2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 PREPARATION

A. Protection:

1. Work Area Protection: Protect work areas from dust and other airborne contaminants during surface preparation and concrete sealer installation.
2. Adjacent Material Protection: Protect adjacent surfaces against soiling and damage. Utilize drop cloths, shields, masking, barricades, and other items necessary to protect adjacent surfaces.
3. Opening Protection: Close and protect drains and other openings and penetrations to prevent concrete sealer intrusion or migration of liquids.

B. Substrate Preparation: Prepare substrates as required, recommended, or accepted by the manufacturer without limitation; and in a manner that does not result in any warranty or guarantee becoming void.

3.3 INSTALLATION

A. General Requirements:
1. Install concrete sealers using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
2. Only install concrete sealers under conditions that ensure finishes are free from blemishes and defects.
3. Provide smooth surfaces of uniform finish, color, appearance, and coverage. concrete sealer surfaces with cloudiness, spotting, holidays, runs, or other imperfections are prohibited and are rejected as non-conforming work.
4. Do not exceed the application rates recommended by the manufacturer.
5. Installed concrete sealers must be warrantable. Do not install, correct, or replace concrete sealers in a manner that results in any warranty or guarantee becoming void.

3.4 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
1. written descriptions of non-conforming, damaged, and defective work;
2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.5 CLEANING

A. Cleaning Work: Clean spills, stains, soiling, overspray, and fallout from adjacent surfaces.
   1. Use cleaning materials, equipment, and accessories supplied, and means, methods, techniques, and procedures required, recommended, or accepted by the manufacturer.
   2. Do not use cleaning materials or procedures known to change, or that might change, the appearance of exposed finishes or adjacent surfaces; or cause deterioration or damage to exposed finishes or adjacent surfaces.
   3. Protect adjacent surfaces not being cleaned from staining, deterioration, damage, or other detrimental effects caused by cleaning.
   4. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be cleaned to the Architect's acceptance.

B. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

3.6 PROTECTION

A. Protect sealed concrete in place from soiling, deterioration, and damage until Substantial Completion.

B. Do not store anything on, adjacent to, or against sealed concrete unless it is protected from damage, as accepted in writing by the manufacturer's representative. Do not use installed sealed concrete surfaces as work surfaces.

END OF SECTION

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DIVISION 10

SPECIALTIES

SECTION 10 11 16 – MARKERBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Porcelain enamel steel markerboards.
   2. Glass markerboards.
   3. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

1.2 REFERENCES

A. Definitions:
   1. Manufacturer: Means the markerboard manufacturer, unless otherwise indicated.

1.3 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data: Submit manufacturer's product data, specifications, typical installation details, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs), and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
   2. Shop Drawings: Include project-specific dimensioned details drawn to scale showing conditions not detailed on the product data; or that are detailed, but not in a manner specific to the project.
   3. Samples:
      a. Submit at least 8-inch square representative samples of each markerboard color, finish, and variety.
      b. Submit at least 8-inch long representative samples of each markerboard trim type, color, finish, and variety.

B. Informational Submittals: Submit manufacturer's instructions for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
   1. Submit manufacturer-prepared published instructions for proper installation of furnished markerboards.

2. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.
3. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.

C. Closeout Submittals: Submit copies of manufacturer's instructions and other requirements and recommendations for markerboard maintenance, cleaning, and repair to the Architect as a condition of project closeout.

1.4 QUALITY ASSURANCE

A. Source Limitations:
1. Markerboards must be obtained through one source from the same manufacturer (to ensure compatibility, regulatory conformance, and a warrantable installation).
   a. Certain items may be obtained from more than one manufacturer, but only when used for separate installations.
   b. Items provided for each different installation must be obtained from the same source and manufacturer.
2. Provide secondary materials, components, accessories and other items from sources required, recommended, or accepted by the primary manufacturer for actual in-service conditions applicable to the project.

1.5 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
2. Reject items that are not transported, delivered, or protected in conformance with manufacturer-recommended transport, delivery, and receiving requirements.
3. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items indoors as shipped, upright in their original packaging or containers, within dry, well-ventilated, broom-cleaned and enclosed storage areas.

C. Handling: Handle items in conformance with manufacturer's instructions and other requirements and recommendations, and in a manner that that prevents damage. Avoid damage to packaging and containers, and contamination of contents.

D. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective markerboards with undamaged new markerboards that do not exhibit deterioration, damage, or defects.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide products manufactured by one of the following, or equal.
   1. Claridge Products and Equipment, Inc.
   2. Clarus Glassboards.
   3. MorreCo Inc.
   4. PolyVision Corp.

2.2 PORCELAIN ENAMEL STEEL MARKERBOARDS

A. Description: Balanced, 3-ply high-pressure laminate boards consisting of face sheet, core material, and backing.

B. Product: “Series 3” manufactured by Claridge Products and Equipment, Inc., or equal.

C. Requisite Properties:
   1. Style: “Type A”, or equal.
   2. Size: Indicated on the Drawings.
   3. Thickness: 1/2-inch.
   4. Writing Surface Color: Selected by the Architect.
   5. Writing Surface Finish: Matte.
   6. Trim: 1-1/2-inch wide clear anodized extruded aluminum.

D. Materials:
   1. Face Sheet: At least 0.0209-inch BMT (MSG 25) porcelain-enameling sheet conforming to ASTM A 424 Type I (direct cover coat), commercial steel (CS), tension-leveled to a flatness of 5 I-units or less.
   2. Core Panel: At least 1/4-inch thick high-density fiberboard (hardboard) conforming to ANSI/AHA A135.4 requirements for Class 1 (tempered) hardboard, S1S (one smooth side).
   3. Backing: At least 0.005-inch thick aluminum foil.

E. Construction:
   1. Provide units in a single un-spliced panel.
   2. Where the dimensions shown exceed available sizes, provide two or more equal size pieces acceptable to the Architect.
   3. Where the dimensions cause delivery in separate units, pre-fit components at the factory, disassemble for delivery, and make final joints at the site. Use splines at joints to maintain surface alignment.

2.3 GLASS MARKERBOARDS

A. Description: 1/4-inch low-iron, back-painted, magnetic glass markerboard with concealed z-bar mount.

B. Products: “Architectural Glass Markerboard" manufactured by Claridge Products and Equipment, Inc., or equal.

C. Requisite Properties:
   1. Size: Indicated on the Drawings.
   2. Orientation: Landscape.
   3. Mounting Height: Indicated on the Drawings.
   4. Mounting: Concealed Z-bar mount.
   5. Color: Selected by the Architect.

D. Materials:
   1. Glass: ASTM C 1048, Kind FT (fully tempered) as indicated, Condition C (spandrel glass, one surface ceramic coated), ultra-clear (low iron) annealed vision glass conforming to ASTM C 1036, Type I (transparent flat glass), Class 1 (clear), Quality Q3 (select glazing applications).

2.4 ACCESSORIES

A. Tray: Provide manufacturer’s standard mechanically-attached blade type trays.

B. Other Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification: Verify in-place supporting and adjacent construction conforms to the manufacturer’s requirements or recommendations and satisfies all other conditions that might affect the quality of installation or the durability, appearance, or performance of installed and adjacent items.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the manufacturer’s instructions and other requirements and recommendations.

2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 INSTALLATION

A. General Requirements:
   1. Install markerboards using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
   2. Set items true to line, to required levels and lines, and plumb, level, and square, without warp or rack, with flush well-fitted joints, and in alignment with adjacent construction
   3. Installed markerboards must be warrantable. Do not install, correct, or replace markerboards in a manner that results in any warranty or guarantee becoming void.

B. Interface with Adjacent Items: Provide materials, components, and accessories normally furnished or necessary to securely attach markerboards to supporting construction.

C. Installation Tolerances: Install markerboards to an allowable tolerance variation of not more than 1/4-inch from true position and not more than 1/8-inch from plumb, level, and alignment.

3.3 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
   1. written descriptions of non-conforming, damaged, and defective work;
   2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
   3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.4 CLEANING

A. Cleaning Work: Clean all visible markerboard surfaces in a manner that does not result in any warranty or guarantee becoming void.
   1. Use cleaning materials, equipment, and accessories supplied, and means, methods, techniques, and procedures required, recommended, or accepted by the manufacturer.
   2. Do not use cleaning materials or procedures known to change, or that might change, the appearance of exposed finishes or adjacent surfaces; or cause deterioration or damage to exposed finishes or adjacent surfaces.
   3. Protect adjacent surfaces not being cleaned from staining, deterioration, damage, or other detrimental effects caused by cleaning.
   4. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be cleaned to the Architect's acceptance.

B. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

3.5 PROTECTION

A. Protect installed markerboards in place from soiling, deterioration, and damage until Substantial Completion.

B. Do not store anything on or adjacent to or against installed markerboards unless they are protected from damage, as accepted in writing by the manufacturer's representative. Do not use installed markerboards as work surfaces.

C. Remove protection when it's no longer needed and before Substantial Completion.

END OF SECTION

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SECTION 10 14 13 – REGULATORY SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Restroom doors signs.
   2. Egress stairway door signs.
   3. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

1.2 REFERENCES

A. Definitions:
   1. Manufacturer: Means the sign material manufacturer, unless otherwise indicated.
   2. Fabricator: Means the sign fabricator, unless otherwise indicated.

1.3 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data: Submit manufacturer's product data, specifications, typical installation details, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs), and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
   2. Shop Drawings: Include project-specific dimensioned details drawn to scale showing conditions not detailed on the product data; or that are detailed, but not in a manner specific to the project.
   3. Samples: Submit at least 8-inch square representative samples of each sign color, finish, and variety.

B. Informational Submittals: Submit manufacturer's instructions for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
   1. Submit manufacturer-prepared published instructions for proper installation of furnished signs.
   2. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.

3. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.

1.4 QUALITY ASSURANCE

A. Source Limitations:
   1. Signs must be obtained through one source from the same manufacturer (to ensure compatibility, regulatory conformance, and a warrantable installation).
      a. Certain items may be obtained from more than one manufacturer, but only when used for separate installations.
      b. Items provided for each different installation must be obtained from the same source and manufacturer.
   2. Provide secondary materials, components, accessories and other items from sources required, recommended, or accepted by the primary manufacturer for actual in-service conditions applicable to the project.

A. Regulatory Requirements:
   1. Chemical Signs and Labels: Provide Proposition 65 signage in conformance with California Code of Regulations (CCR), Title 27.
   2. Raised Characters: Raised characters must conform to the requirements of California Building Code Section 11B-703.2:
   3. Depth: It must be 1/32-inch (0.8 mm) minimum above their background and must be sans serif uppercase and be duplicated in Braille.
   4. Height: It must be 5/8-inch (15.9 mm) minimum and 2 inches (51 mm) maximum based on the height of the uppercase letter "I". California Building Code Section 11B-703.2.5
   5. Finish and Contrast: Characters and their background must have a non-glare finish. Character must contrast with their background with either light characters on a dark background or dark characters on a light background. California Building Code Section 11B-703.5.1
   6. Proportions: It must be selected from fonts where the width of the uppercase letter "O" is 60 percent minimum and 110 percent maximum of the height of the uppercase letter "I". Stroke thickness of the uppercase letter "I" must be 15 percent maximum of the height of the character. California Building Code Sections 11B-703.2.4 and 11B-703.2.6
   7. Character Spacing: Spacing between individual raised characters must conform to the requirements of California Building Code Section 11B-703.2.7 and 11B-703.2.8
   8. Format: Text must be in a horizontal format. California Building Code Section 11B-703.2.9
   9. Braille: It must be contracted (Grade 2) and must conform to the requirements of California Building Code Sections 11B-703.3 and 11B-703.4. Braille dots must have a domed or rounded shape and must conform to the requirements of California Building Code Table and Figure 11B-703.3.1.

10. Mounting Height: Tactile characters on signs must be located 48 inches minimum to the baseline of the lowest Braille cells and 60 inches maximum to the baseline of the highest line of raised characters above the finish floor or ground surface. California Building Code Section and Figure 11B-703.4.1
11. Mounting Location: A tactile sign must be located per California Building Code Section and Figure 11B -703.4.2 as follows:
    a. alongside a single door at the latch side.
    b. on the inactive leaf at double doors with one active leaf.
    c. to the right of the right hand door at double doors with two active leaves.
    d. on the nearest adjacent wall where there is no wall space at the latch side of a single door or at the right side of double doors with two active leaves.
    e. so that a clear floor space of 18 inches by 18 inches minimum, centered on the tactile characters, is provided beyond the arc of any door swing between the closed position and 45 degree open position.
12. Visual characters must conform to the requirements of California Building Code Section 11B-703.5 and must be 40 inches minimum above finish floor or ground.
13. Pictograms must conform to the requirements of California Building Code Section 11B-703.6.
14. Symbols of accessibility must conform to the requirements of California Building Code Section 11B-703.7.
15. Variable message signs must conform to the requirements of California Building Code Section 11B-703.8.

1.5 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
    1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
    2. Reject items that are not transported, delivered, or protected in conformance with manufacturer-recommended transport, delivery, and receiving requirements.
    3. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items indoors as shipped, upright in their original packaging or containers, within dry, well-ventilated, broom-cleaned and enclosed storage areas.

C. Handling: Handle items in conformance with manufacturer's instructions and other requirements and recommendations, and in a manner that that prevents damage. Avoid damage to packaging and containers, and contamination of contents.

D. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective signs with undamaged new signs that do not exhibit deterioration, damage, or defects.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

PART 2 - PRODUCTS

2.1 PHOTOPOLYMER PANEL SIGNS

A. Description: Single-piece photopolymer panel permanent identification signs consisting of moisture resistant non-glare photopolymer bonded to sign base material.

B. Manufacturer: Provide photopolymer products manufactured by Nova Polymers, Inc., or equal.

C. Fabricators: Provide signs fabricated by one of the following, or equal.
   1. Neiman & Co.
   2. Signtech Inc.

D. Materials:
   1. Photopolymer Layer: 0.040-inch acrylic photopolymer.
   2. Base Material:
      a. Interior Locations: 0.120-inch phenolic base.
      b. Exterior Locations: Exterior grade photopolymer applied to a 0.120-inch phenolic base.

E. Requisite Properties:
   1. Overall Panel Thickness: Between 1/8- and 1/4-inch.
   2. Colors: Indicated on the Drawings or selected by the Architect.
   3. Finish: Furnish non-glare finish.
   4. Edge Condition: Square cut.
   5. Corner Condition: Square.
   6. Mounting: Indicated on the Drawings.
   7. Copy: Indicated on the Drawings or selected by the Architect.
      a. Letter spacing must conform to standards shown and kerned optically to the acceptance of the Architect.
      b. Lines of copy must be straight and parallel to the sign format, unless otherwise indicated.
      c. Edges of letters, numbers, and symbols must be smooth and continuous, with straight and curved portions reproducing the original forms exactly, with corners sharp and true.
      d. All forms must be free from ticks, line waiver, discontinuous curves, and other imperfections.
   8. Font: Indicated on the Drawings or selected by the Architect.

2.2 INSTALLATION MATERIALS

A. Fasteners: Non-removable mechanical fasteners and anchors suitable for secure attachment to substrate and placed through predrilled holes as recommended in writing by the sign manufacturer.
   1. Exposed Fasteners: Exposed fasteners are permitted only where specifically stated in the drawings and must be stainless steel painted or finished to match adjacent surfaces, unless otherwise indicated.
   2. Concealed Fasteners: Fabricate from metals that are not corrosive to the sign material and mounting surface.

B. Tape: “VHB Tape” manufactured by 3M, or equal.

C. Adhesive: “732 Multi-Purpose Sealant Clear” manufactured by Dow Corning Corp., or equal.

2.3 ACCESSORIES

A. Plastic Cement: “WELD-ON 4” manufactured by IPC Corp., or equal.

B. Other Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification: Verify in-place supporting and adjacent construction conforms to the manufacturer’s requirements or recommendations and satisfies all other conditions that might affect the quality of installation or the durability, appearance, or performance of installed and adjacent items.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the manufacturer’s instructions and other requirements and recommendations.
   2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 INSTALLATION

A. General Requirements:
   1. Install signs using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
   2. Set items true to line, to required levels and lines, and plumb, level, and square, without warp or rack, with flush well-fitted joints, and in alignment with adjacent construction
   3. Installed signs must be warrantable. Do not install, correct, or replace signs in a manner that results in any warranty or guarantee becoming void.

B. Interface with Adjacent Items: Provide materials, components, and accessories normally furnished or necessary to securely attach signs to supporting construction.

C. Installation Tolerances: Install signs to an allowable tolerance variation of not more than 1/4-inch from true position and not more than 1/8-inch from plumb, level, and alignment.

3.3 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
   1. written descriptions of non-conforming, damaged, and defective work;
   2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
   3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect’s acceptance.

3.4 CLEANING

A. Cleaning Work: Clean all visible sign surfaces in a manner that does not result in any warranty or guarantee becoming void.
   1. Use cleaning materials, equipment, and accessories supplied, and means, methods, techniques, and procedures required, recommended, or accepted by the manufacturer.

2. Do not use cleaning materials or procedures known to change, or that might change, the appearance of exposed finishes or adjacent surfaces; or cause deterioration or damage to exposed finishes or adjacent surfaces.
3. Protect adjacent surfaces not being cleaned from staining, deterioration, damage, or other detrimental effects caused by cleaning.
4. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be cleaned to the Architect's acceptance.

B. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

3.5 PROTECTION

A. Protect installed signs in place from soiling, deterioration, and damage until Substantial Completion.

B. Do not store anything on or adjacent to or against installed signs unless they are protected from damage, as accepted in writing by the manufacturer's representative. Do not use installed signs as work surfaces.

C. Remove protection when it's no longer needed and before Substantial Completion.

END OF SECTION

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SECTION 10 21 33 – CUBICLE CURTAINS AND TRACK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Cubicle curtains.
   2. Curtain tracks.
   3. Curtain carriers.
   4. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

1.2 REFERENCES

A. Definitions:
   1. Manufacturer: Means the cubicle curtain or track manufacturer, as the case admits, unless otherwise indicated.

1.3 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data: Submit manufacturer's product data, specifications, typical installation details, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs), and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
   2. Shop Drawings:
      a. Submit dimensioned plans and elevations drawn to scale and showing curtain and track layout, materials, construction, and finishes. Show locations, sizes, and extents of all items, accessories, and trim. Label manufactured items by product name.
      b. Include project-specific dimensioned details drawn to scale showing conditions not detailed on the product data; or that are detailed, but not in a manner specific to the project. Cross-reference details to plans and elevations.
   3. Samples: Submit at least 8-inch square representative samples of each curtain and track color, finish, and variety.

B. Informational Submittals: Submit manufacturer's instructions for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
   1. Submit manufacturer-prepared published instructions for proper installation of furnished curtains and tracks.
   2. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.
   3. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.

C. Maintenance Material Submittals: Deliver extra stock materials to the Architect before Final Completion.
   1. Curtain Carriers and Track End Caps: Furnish full-size units equal to 3 percent of the amount installed for each size and type indicated.
   2. Curtains: Full-size units from the same manufacturer dye lot, or from consecutive lots, matching those installed, equal to 10 percent of amount installed for each size indicated, but no fewer than 2 units.
   3. Properly package and identify extra stock materials for use for future maintenance, repair, or replacement.

1.4 QUALITY ASSURANCE

A. Source Limitations:
   1. Curtains and tracks must be obtained through one source from the same manufacturer (to ensure compatibility, regulatory conformance, and a warrantable installation).
      a. Certain items may be obtained from more than one manufacturer, but only when used for separate installations.
      b. Items provided for each different installation must be obtained from the same source and manufacturer.
   2. Provide secondary materials, components, accessories and other items from sources required, recommended, or accepted by the primary manufacturer for actual in-service conditions applicable to the project.

A. Regulatory Requirements:
   1. Curtain Fabric: Fabric must be identified, with appropriate markings of the applicable testing and inspecting agency, as having required flame-resistant properties.

1.5 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.

1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
2. Reject items that are not transported, delivered, or protected in conformance with manufacturer-recommended transport, delivery, and receiving requirements.
3. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items indoors as shipped, upright in their original packaging or containers, within dry, well-ventilated, broom-cleaned and enclosed storage areas.

C. Handling: Handle items in conformance with manufacturer's instructions and other requirements and recommendations, and in a manner that that prevents damage. Avoid damage to packaging and containers, and contamination of contents.

D. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective curtains and tracks with undamaged new curtains and tracks that do not exhibit deterioration, damage, or defects.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

PART 2 - PRODUCTS

2.1 CUBICLE CURTAINS

A. Description: Contract textiles manufactured for privacy applications and fabricated into curtains consisting of a textile privacy panel with a mesh top.

B. Manufacturers: Provide products manufactured by one of the following, or equal.
1. Carnegie Fabrics, LLC.
2. KnollTextiles.
3. Luna Textiles.
4. Maharam.

C. Product: Selected by the Architect, or equal.

D. Performance Requirements: Curtain fabrics must be
1. launderable to a temperature of at least 160 deg. F;
2. flame-resistant and identical to those fabrics having passed the requirements of NFPA publication NFPA 701, "Standard Methods of Fire Tests for Flame Propagation of Textiles and Films", when tested by a qualified testing and inspection agency acceptable to the AHJ; and
3. identified with the appropriate markings of the applicable qualified testing and inspection agency.

E. Accessories:

1. Tiebacks: Provide flame-resistant, woven polyester straps with self-adhering aluminum wall attachment plates.
2. Other Accessories: Provide other accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

2.2 CURTAIN TRACKS

A. Description: Surface-mounted extruded-aluminum cubicle curtain track systems.

B. Products: “Narrowline Aluminum Track” manufactured by Construction Specialties, Inc., or equal.

C. Requisite Properties:
1. Curved Track: Provide curved track factory-fabricated in one continuous “L” shape with at least 12-inch radius bends.
2. Finish: Manufacturer’s standard clear anodized finish.

D. Components: Provide splices, end caps, connectors, removable end stops, coupling and joining sleeves, wall flanges, brackets, ceiling clips, and other accessories as supplied, required, recommended, approved, or accepted by the curtain track manufacturer.

E. Accessories:
1. Fasteners: Provide exposed and concealed stainless steel fasteners.
2. Other Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

2.3 CURTAIN CARRIERS

A. Description:
1. Curtain Carriers: 2-wheel carriers, with rollers and axles manufactured from virgin nylon, and nickel-plated brass or steel bead chains and hard aluminum hooks; provide at least 2.2 rollers per linear foot of track.

B. Manufacturers: Provide products manufactured by one of the following, or equal.
1. Capital Cubicle.
2. Construction Specialties, Inc.
3. Cubicle Curtain Factory, Inc.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification: Verify in-place supporting and adjacent construction conforms to the manufacturer's requirements or recommendations and satisfies all other conditions that might affect the quality of installation or the durability, appearance, or performance of installed and adjacent items.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.
   2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 INSTALLATION

A. General Requirements:
   1. Install curtains and tracks using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
   2. Set items true to line, to required levels and lines, and plumb, level, and square, without warp or rack, with flush well-fitted joints, and in alignment with adjacent construction
   3. Installed curtains and tracks must be warrantable. Do not install, correct, or replace curtains and tracks in a manner that results in any warranty or guarantee becoming void.

B. Interface with Adjacent Items: Provide materials, components, and accessories normally furnished or necessary to securely attach curtains and tracks to supporting construction.

C. Installation Tolerances: Install curtains and tracks to an allowable tolerance variation of not more than 1/4-inch from true position and not more than 1/8-inch from plumb, level, and alignment.

3.3 ADJUSTING

A. Verify smooth and quiet curtain and track operation.

B. Lubricate and adjust operating parts to function properly, free from warp, twist, binding, and distortion. Confirm latches and locks engage securely without forcing or binding.

C. Replace items that do not operate freely in a safe and reliable manner.

3.4 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
   1. written descriptions of non-conforming, damaged, and defective work;
   2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
   3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.5 CLEANING

A. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

3.6 PROTECTION

A. Protect installed curtains and tracks in place from soiling, deterioration, and damage until Substantial Completion.

B. Do not store anything on or adjacent to or against installed curtains and tracks unless they are protected from damage, as accepted in writing by the manufacturer's representative. Do not use installed curtains and tracks as work surfaces.

C. Remove protection when it's no longer needed and before Substantial Completion.

END OF SECTION

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SECTION 10 26 00 – WALL PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Corner guards.
   2. Resinous protective wall covering.
   3. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

1.2 REFERENCES

A. Definitions:
   1. Manufacturer: Means the wall protection manufacturer, unless otherwise indicated.

1.3 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data: Submit manufacturer's product data, specifications, typical installation details, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs), and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
   2. Shop Drawings: Include project-specific dimensioned details drawn to scale showing conditions not detailed on the product data; or that are detailed, but not in a manner specific to the project.
   3. Samples:
      a. Submit at least 8-inch square representative samples of each protective wall covering color, finish, and variety.
      b. Submit at least 6-inch long representative samples of each corner guard type, color, finish, and variety.

B. Informational Submittals: Submit manufacturer's instructions for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
   1. Submit manufacturer-prepared published instructions for proper installation of furnished wall protection.

2. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.
3. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.

1.4 QUALITY ASSURANCE

A. Source Limitations:
   1. Wall protection must be obtained through one source from the same manufacturer (to ensure compatibility, regulatory conformance, and a warrantable installation).
      a. Certain items may be obtained from more than one manufacturer, but only when used for separate installations.
      b. Items provided for each different installation must be obtained from the same source and manufacturer.
   2. Provide secondary materials, components, accessories and other items from sources required, recommended, or accepted by the primary manufacturer for actual in-service conditions applicable to the project.

B. Regulatory Requirements:
   1. Surface-Burning Characteristics: Provide wall protection having a maximum FSI Value of 25 or less and a maximum SDI Value of less than 450 (Class A), when tested in conformance with ASTM E 84.

1.5 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
   1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
   2. Reject items that are not transported, delivered, or protected in conformance with manufacturer-recommended transport, delivery, and receiving requirements.
   3. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items indoors as shipped, upright in their original packaging or containers, within dry, well-ventilated, broom-cleaned and enclosed storage areas.

C. Handling: Handle items in conformance with manufacturer's instructions and other requirements and recommendations, and in a manner that that prevents damage. Avoid damage to packaging and containers, and contamination of contents.

D. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective items with undamaged new items that do not exhibit deterioration, damage, or defects.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

PART 2 - PRODUCTS

2.1 CORNER GUARDS

A. Products: Indicated on the Drawing in Finish Schedule IE601., or equal.

2.2 RESINOUS PROTECTIVE WALL COVERING

A. Products: Indicated on the Drawings in the Finish Schedule Sheet IE601., or equal.

2.3 ACCESSORIES

A. Fastenings: Provide backings, inserts, loose connection hardware, fasteners, anchors, attachments, connectors, and other items supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

B. Mounting and Material Adhesives: Structural-grade silicone or epoxy adhesives of type recommended or accepted by manufacturer for conditions of use.

C. Sealant:
   1. Description: Clear or white, medium or high modulus, mildew-resistant silicone sealant conforming to ASTM C 920 requirements for Type S, Grade NS, Class 25, Use NT, A or O sealant, as applicable.
   2. Products: “786” manufactured by Dow Corning Corp., or “Sanitary SCS 1700” manufactured by Momentive Performance Materials, Inc., or equal.

D. Solvent: Supplied, required, recommended, or accepted by the manufacturer to clean substrates to ensure adhesion of adhesives and sealants.

E. Cleaner: Supplied, required, recommended, or accepted by the manufacturer for use on installed wall protection and actual in-service conditions applicable to the project. Cleaners must remove stains, dirt, and residue without damaging or altering wall protection surfaces.

F. Other Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification: Verify in-place supporting and adjacent construction conforms to the manufacturer's requirements or recommendations and satisfies all other conditions that might affect the quality of installation or the durability, appearance, or performance of installed and adjacent items.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.
   2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 INSTALLATION

A. General Requirements:
   1. Install wall protection using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
   2. Set items true to line, to required levels and lines, and plumb, level, and square, without warp or rack, with flush well-fitted joints, and in alignment with adjacent construction
   3. Installed wall protection must be warrantable. Do not install, correct, or replace wall protection in a manner that results in any warranty or guarantee becoming void.

B. Interface with Adjacent Items: Provide materials, components, and accessories normally furnished or necessary to securely attach wall protection to supporting construction.

C. Installation Tolerances: Install wall protection to an allowable tolerance variation of not more than 1/4-inch from true position and not more than 1/8-inch from plumb, level, and alignment.

3.3 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
   1. written descriptions of non-conforming, damaged, and defective work;
   2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
   3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.4 CLEANING

A. Cleaning Work: Clean all visible wall protection surfaces in a manner that does not result in any warranty or guarantee becoming void.
   1. Use cleaning materials, equipment, and accessories supplied, and means, methods, techniques, and procedures required, recommended, or accepted by the manufacturer.
   2. Do not use cleaning materials or procedures known to change, or that might change, the appearance of exposed finishes or adjacent surfaces; or cause deterioration or damage to exposed finishes or adjacent surfaces.
   3. Protect adjacent surfaces not being cleaned from staining, deterioration, damage, or other detrimental effects caused by cleaning.
   4. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be cleaned to the Architect's acceptance.

B. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

3.5 PROTECTION

A. Protect installed wall protection in place from soiling, deterioration, and damage until Substantial Completion.

B. Do not store anything on or adjacent to or against installed wall protection unless they are protected from damage, as accepted in writing by the manufacturer's representative. Do not use installed wall protection as work surfaces.

C. Remove protection when it's no longer needed and before Substantial Completion.

END OF SECTION

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SECTION 10 28 13 – COMMERCIAL TOILET ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Commercial toilet accessories.
   2. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

1.2 REFERENCES

A. Definitions:
   1. Manufacturer: Means the toilet accessory manufacturer, unless otherwise indicated.

1.3 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data: Submit manufacturer's product data, specifications, typical installation details, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs), and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
   2. Shop Drawings: Include project-specific dimensioned details drawn to scale showing conditions not detailed on the product data; or that are detailed, but not in a manner specific to the project.

B. Informational Submittals: Submit manufacturer's instructions for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
   1. Submit manufacturer-prepared published instructions for proper installation of furnished toilet accessories.
   2. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.
   3. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.

1.4 QUALITY ASSURANCE

A. Source Limitations:
   1. Toilet accessories must be obtained through one source from the same manufacturer (to ensure compatibility, regulatory conformance, and a warrantable installation).
      a. Certain items may be obtained from more than one manufacturer, but only when used for separate installations.
      b. Items provided for each different installation must be obtained from the same source and manufacturer.
   2. Provide secondary materials, components, accessories and other items from sources required, recommended, or accepted by the primary manufacturer for actual in-service conditions applicable to the project.

B. Regulatory Requirements:
   1. Elements of sanitary facilities must be mounted at locations in conformance with California Building Code Sections 11B-602 through 11B-612.
   2. Grab bars in toilet facilities and bathing facilities must conform to the requirements of California Building Code Section 11B-609. Grab bars and any wall or other surfaces adjacent to grab bars must be free of sharp or abrasive elements and must have rounded edges. The space around the grab bars must be as follows:
      a. 1-1/2-inch between the grab bar and the wall.
      b. 1-1/2-inch minimum between the grab bar and projecting objects below and at the ends.
      c. 12 inches minimum between the grab bar and projecting objects above.

1.5 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
   1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
   2. Reject items that are not transported, delivered, or protected in conformance with manufacturer-recommended transport, delivery, and receiving requirements.
   3. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items indoors as shipped, upright in their original packaging or containers, within dry, well-ventilated, broom-cleaned and enclosed storage areas.

C. Handling: Handle items in conformance with manufacturer's instructions and other requirements and recommendations, and in a manner that that prevents damage. Avoid damage to packaging and containers, and contamination of contents.

D. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective toilet accessories with undamaged new toilet accessories that do not exhibit deterioration, damage, or defects.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide products manufactured by one of the following, or equal.
   1. Bobrick Washroom Equipment, Inc.
   2. Bradley Corp.

2.2 COMMERCIAL TOILET ACCESSORIES

A. Products: Selected by the Architect, or equal.

B. Materials:
   1. Stainless-Steel Sheet: ASTM A 666 (annealed and tempered) Type 304 tension leveled to a flatness of 5 I-units or less.
   2. Mirrored Glass: ASTM C 1503, Q-1 Mirror Select Quality.

2.3 ACCESSORIES

A. Pipe Guards:
   1. Description: Insulating antimicrobial, molded plastic, white pipe covering for supply and drain piping assemblies that prevent direct contact with and burns from piping; allow service access without removing coverings.
   2. Manufacturers: Provide products manufactured by one of the following, or equal.
      a. Plumberex Specialty Products, Inc.
      b. IPS Corp.

B. Fastenings: Provide backings, inserts, loose connection hardware, fasteners, anchors, attachments, connectors, and other items supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

C. Other Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification: Verify in-place supporting and adjacent construction conforms to the manufacturer's requirements or recommendations and satisfies all other conditions that might affect the quality of installation or the durability, appearance, or performance of installed and adjacent items.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.
   2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 INSTALLATION

A. General Requirements:
   1. Install toilet accessories using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
   2. Set items true to line, to required levels and lines, and plumb, level, and square, without warp or rack, with flush well-fitted joints, and in alignment with adjacent construction
   3. Installed toilet accessories must be warrantable. Do not install, correct, or replace toilet accessories in a manner that results in any warranty or guarantee becoming void.

B. Interface with Adjacent Items: Provide materials, components, and accessories normally furnished or necessary to securely attach toilet accessories to supporting construction.

C. Installation Tolerances: Install toilet accessories to an allowable tolerance variation of not more than 1/4-inch from true position and not more than 1/8-inch from plumb, level, and alignment.

3.3 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including

arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
   1. written descriptions of non-conforming, damaged, and defective work;
   2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
   3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.4 CLEANING

A. Cleaning Work: Clean all visible toilet accessory surfaces in a manner that does not result in any warranty or guarantee becoming void.
   1. Use cleaning materials, equipment, and accessories supplied, and means, methods, techniques, and procedures required, recommended, or accepted by the manufacturer.
   2. Do not use cleaning materials or procedures known to change, or that might change, the appearance of exposed finishes or adjacent surfaces; or cause deterioration or damage to exposed finishes or adjacent surfaces.
   3. Protect adjacent surfaces not being cleaned from staining, deterioration, damage, or other detrimental effects caused by cleaning.
   4. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be cleaned to the Architect's acceptance.

B. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

3.5 PROTECTION

A. Protect installed toilet accessories in place from soiling, deterioration, and damage until Substantial Completion.

B. Do not store anything on or adjacent to or against installed toilet accessories unless they are protected from damage, as accepted in writing by the manufacturer's representative. Do not use installed toilet accessories as work surfaces.

C. Remove protection when it's no longer needed and before Substantial Completion.

END OF SECTION

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SECTION 10 28 14 – COMMERCIAL SHOWER ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Shower curtains.
   2. Shower curtain rods.
   3. Shower curtain hooks.
   4. Shower seats.
   5. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

1.2 REFERENCES

A. Definitions:
   1. Manufacturer: Means the shower accessory manufacturer, unless otherwise indicated.

1.3 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data: Submit manufacturer's product data, specifications, typical installation details, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs), and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
   2. Shop Drawings: Include project-specific dimensioned details drawn to scale showing conditions not detailed on the product data; or that are detailed, but not in a manner specific to the project.

B. Informational Submittals: Submit manufacturer's instructions for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
   1. Submit manufacturer-prepared published instructions for proper installation of furnished shower accessories.
   2. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.

3. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.

1.4 QUALITY ASSURANCE

A. Source Limitations:
   1. Shower accessories must be obtained through one source from the same manufacturer (to ensure compatibility, regulatory conformance, and a warrantable installation).
      a. Certain items may be obtained from more than one manufacturer, but only when used for separate installations.
      b. Items provided for each different installation must be obtained from the same source and manufacturer.
   2. Provide secondary materials, components, accessories and other items from sources required, recommended, or accepted by the primary manufacturer for actual in-service conditions applicable to the project.

1.5 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
   1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
   2. Reject items that are not transported, delivered, or protected in conformance with manufacturer-recommended transport, delivery, and receiving requirements.
   3. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items indoors as shipped, upright in their original packaging or containers, within dry, well-ventilated, broom-cleaned and enclosed storage areas.

C. Handling: Handle items in conformance with manufacturer's instructions and other requirements and recommendations, and in a manner that that prevents damage. Avoid damage to packaging and containers, and contamination of contents.

D. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective shower accessories with undamaged new shower accessories that do not exhibit deterioration, damage, or defects.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide products manufactured by one of the following, or equal.
   1. Bobrick Washroom Equipment, Inc.
   2. Bradley Corp.

2.2 SHOWER CURTAINS

A. Product: “Model B-204” manufactured by Bobrick Washroom Equipment, Inc., or equal.

B. Requisite Properties:
   1. Overall Curtain Width: Equal to the curtain rod length plus either 10 percent or at least 12 inches, whichever is greater, for added fullness.
   2. Overall Curtain Length: 72 inches.
   3. Material: Matte white vinyl with antibacterial and flame-retardant agents.
   4. Minimum Fabric Thickness: At least 0.008-inch thick.
   5. Hems: Bottom and sides must be hemmed.
   6. Grommets: Nickel-plated brass grommets spaced every 6 inches on center along the top of curtain.

2.3 SHOWER CURTAIN RODS

A. Product: “Model B-6047” manufactured by Bobrick Washroom Equipment, Inc., or equal.

B. Requisite Properties:
   1. Curtain Rod: 18-8 S, Type 304, stainless steel with satin finish.
   2. Flanges: Same material and finish as curtain rod; drawn, one-piece seamless construction (heavy- and extra-heavy-duty rods).
   3. Curtain Rod and Flange Thickness: At least 0.050-inch BMT (USSG 18).
   4. Curtain Rod Outside Diameter: 1-1/4 inches.
   5. Mounting: Concealed aluminum brackets.
   6. Backing: Specified in Section 05 40 00.

2.4 SHOWER CURTAIN HOOKS

A. Product: “Part No. 204-1” shower curtain hooks manufactured by Bobrick Washroom Equipment, Inc., or equal.

B. Material: 0.09-inch diameter stainless steel Type 304.

2.5 STANDARD SHOWER SEATS

A. Reversible Folding Shower Seat:
   1. Product: “Model B-5181” manufactured by Bobrick Washroom Equipment, Inc., or equal.
   2. Requisite Properties:
      a. Seat: One-piece, 1/2-inch thick solid phenolic core seat with matte-finish melamine surfaces and black phenolic resin core.
      b. Support: Stainless steel with self-locking mechanism.

2.6 ACCESSORIES

A. Fastenings: Provide backings, inserts, loose connection hardware, fasteners, anchors, attachments, connectors, and other items supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

B. Other Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification: Verify in-place supporting and adjacent construction conforms to the manufacturer’s requirements or recommendations and satisfies all other conditions that might affect the quality of installation or the durability, appearance, or performance of installed and adjacent items.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the manufacturer’s instructions and other requirements and recommendations.
   2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 INSTALLATION

A. General Requirements:

1. Install shower accessories using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
2. Set items true to line, to required levels and lines, and plumb, level, and square, without warp or rack, with flush well-fitted joints, and in alignment with adjacent construction
3. Installed shower accessories must be warrantable. Do not install, correct, or replace shower accessories in a manner that results in any warranty or guarantee becoming void.

B. Interface with Adjacent Items: Provide materials, components, and accessories normally furnished or necessary to securely attach shower accessories to supporting construction.

C. Installation Tolerances: Install shower accessories to an allowable tolerance variation of not more than 1/4-inch from true position and not more than 1/8-inch from plumb, level, and alignment.

3.3 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
   1. written descriptions of non-conforming, damaged, and defective work;
   2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
   3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.4 CLEANING

A. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

3.5 PROTECTION

A. Protect installed shower accessories in place from soiling, deterioration, and damage until Substantial Completion.

B. Do not store anything on or adjacent to or against installed shower accessories unless they are protected from damage, as accepted in writing by the manufacturer's representative. Do not use installed shower accessories as work surfaces.

C. Remove protection when it's no longer needed and before Substantial Completion.

END OF SECTION

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SECTION 10 44 00 – FIRE PROTECTION SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fire extinguishers.
   2. Fire extinguisher cabinets.
   3. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

1.2 REFERENCES

A. Definitions:
   1. Manufacturer: Means the fire protection specialty manufacturer, unless otherwise indicated.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate size of fire extinguisher cabinets to ensure specified fire extinguishers and capacities are accommodated.
   2. Coordinate sizes and locations of fire extinguisher cabinets with wall depths.
   3. Final location of fire extinguisher cabinets is subject to fire marshal approval.
      a. Verify cabinet locations with both the fire marshal and the Architect during the framing stage of the project.
      b. Positioning of cabinets at locations other than where indicated are at no additional cost to the Owner.
   4. Where extinguishers are not indicated, assume cabinets and extinguishers are located within 75 feet of any point in the building, or at a rate of one for each 3,000 square feet of building area, or portion thereof, whichever yields the greater number of fire extinguishers.

1.4 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data: Submit manufacturer’s product data, specifications, typical installation details, and all other information necessary to show conformance to the Contract

Documents, excluding material safety data sheets (MSDSs), and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.

2. Shop Drawings:
   a. Submit dimensioned plans and elevations drawn to scale and showing fire extinguisher cabinet locations, sizes, and extents of all items, accessories, and trim. Label manufactured items by product name.
   b. Include project-specific dimensioned details drawn to scale showing conditions not detailed on the product data; or that are detailed, but not in a manner specific to the project. Cross-reference details to plans and elevations.

B. Informational Submittals: Submit manufacturer's instructions for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
   1. Submit manufacturer-prepared published instructions for proper installation of furnished fire protection specialties.
   2. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.
   3. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.

1.5 QUALITY ASSURANCE

A. Source Limitations:
   1. Fire protection specialties must be obtained through one source from the same manufacturer (to ensure compatibility, regulatory conformance, and a warrantable installation).
      a. Certain items may be obtained from more than one manufacturer, but only when used for separate installations.
      b. Items provided for each different installation must be obtained from the same source and manufacturer.
   2. Provide secondary materials, components, accessories and other items from sources required, recommended, or accepted by the primary manufacturer for actual in-service conditions applicable to the project.

B. Regulatory Requirements:
   1. Mounting Height: When installed within the cabinet, bracket-mounted extinguisher handles height must conform to the prescribed limits for an ADA-accessible front-approach reach.
   2. UL Listing:
      a. Provide UL-listed fire extinguishers bearing the UL listing mark for type, fire classification, and rating specified.
      b. Provide cabinets with the same fire rating as wall in which they are installed.

1.6 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
   1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
   2. Reject items that are not transported, delivered, or protected in conformance with manufacturer-recommended transport, delivery, and receiving requirements.
   3. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items indoors as shipped, upright in their original packaging or containers, within dry, well-ventilated, broom-cleaned and enclosed storage areas.

C. Handling: Handle items in conformance with manufacturer's instructions and other requirements and recommendations, and in a manner that that prevents damage. Avoid damage to packaging and containers, and contamination of contents.

D. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective fire protection specialties with undamaged new fire protection specialties that do not exhibit deterioration, damage, or defects.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide products manufactured by one of the following, or equal.
   1. Activar Construction Products Group, Inc.
   2. Larsen's Manufacturing Co.
   3. Potter Roemer Fire Protection Equipment.

2.2 FIRE EXTINGUISHERS

A. Description: UL-listed, heavy duty, enameled steel cylinder, multi-purpose dry chemical fire extinguishers conforming to NFPA 10 requirements for portable extinguishers, and bearing the UL listing mark for type, fire classification, and rating specified.

B. Products: "JL Industries Cosmic 10E" manufactured by Activar Construction Products Group, Inc., or equal.

C. Requisite Properties:
   1. Capacity: 10 pounds.
   2. UL Rating: 4-A:80-B:C.

3. Cylinder Diameter: Not more than 5-1/4 inches.
4. Overall Height: Not more than 22 inches.

2.3 FIRE EXTINGUISHER CABINETS

A. Description: Fire extinguisher cabinets conforming to ASTM E 814 when installed within fire-resistance rated wall assemblies. Cabinets must have the same fire-resistance rating as the wall in which they are installed.

B. Stainless Steel Cabinets:
   1. Products: “JL Industries Cosmopolitan Series” manufactured by Activar Construction Products Group, Inc., or equal.
      a. Flat Trim Recessed Cabinets: “Model No. 1035V17” (non-locking) or “Model No. 1035W17” (locking).
      b. Square Trim Semi-Recessed Cabinets: “Model No. 1036V17” (non-locking) or “Model No. 8136W17” (locking).
      c. Surface-Mounted Square Cabinets: “Model No. 1033V17” (non-locking) or “Model No. 1033W17” (locking).
      d. Fire-Rated Cabinets: Provide model numbers with the “-FX2” suffix for fire rated tub option at fire-resistance rated construction.
   2. Requisite Properties:
      a. Door Style: “Vertical Duo” with tempered safety glass.
      b. Tub Size: 10-1/2 inches wide by 24 inches high by 6 inches deep.
      c. Frame Size: 13-5/8 inches wide by 27-1/8 inches.
      d. Non-Rated Cabinet Rough Opening Size: 11-1/2 inches wide by 25 inches high by 6-1/8 inches deep.
      e. Fire-Rated Cabinet Rough Opening Size: 12-13/16 inches wide by 26-5/16 inches high by 6-11/16 inches deep.
      f. Finish: Stainless steel No. 6 (satin) finish.
      g. Door Hardware: Standard pull handle with “Saf-T-Lok”, or equal where indicated as locked.

C. Accessories:
   1. Mounting Brackets:
      a. Provide manufacturer's standard brackets sized as required for specified extinguishers; manufacturer's standard finish.
      b. Provide brackets for all extinguishers, including those mounted in cabinets. Provide manufacturer’s standard J-hook wall brackets for extinguishers installed within fire extinguisher cabinets.
   2. Other Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification: Verify in-place supporting and adjacent construction conforms to the manufacturer's requirements or recommendations and satisfies all other conditions that might affect the quality of installation or the durability, appearance, or performance of installed and adjacent items.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.
   2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 INSTALLATION

A. General Requirements:
   1. Install fire protection specialties using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
   2. Set items true to line, to required levels and lines, and plumb, level, and square, without warp or rack, with flush well-fitted joints, and in alignment with adjacent construction
   3. Installed fire protection specialties must be warrantable. Do not install, correct, or replace fire protection specialties in a manner that results in any warranty or guarantee becoming void.

B. Interface with Adjacent Items: Provide materials, components, and accessories normally furnished or necessary to securely attach fire protection specialties to supporting construction.

C. Installation Tolerances: Install fire protection specialties to an allowable tolerance variation of not more than 1/4-inch from true position and not more than 1/8-inch from plumb, level, and alignment.

3.3 ADJUSTING

A. Verify smooth and quiet fire extinguisher cabinetdoor and hardware operation.

B. Lubricate and adjust operating parts and hardware to function properly, free from warp, twist, binding, and distortion. Confirm latches and locks engage securely without forcing or binding.

C. Replace items that do not operate freely in a safe and reliable manner.

3.4 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
   1. written descriptions of non-conforming, damaged, and defective work;
   2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
   3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.5 CLEANING

A. Cleaning Work: Clean all visible fire extinguisher cabinetsurfaces in a manner that does not result in any warranty or guarantee becoming void.
   1. Use cleaning materials, equipment, and accessories supplied, and means, methods, techniques, and procedures required, recommended, or accepted by the manufacturer.
   2. Do not use cleaning materials or procedures known to change, or that might change, the appearance of exposed finishes or adjacent surfaces; or cause deterioration or damage to exposed finishes or adjacent surfaces.
   3. Protect adjacent surfaces not being cleaned from staining, deterioration, damage, or other detrimental effects caused by cleaning.
   4. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be cleaned to the Architect's acceptance.

B. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

3.6 PROTECTION

A. Protect installed fire protection specialties in place from soiling, deterioration, and damage until Substantial Completion.

B. Do not store anything on or adjacent to or against installed fire protection specialties unless they are protected from damage, as accepted in writing by the manufacturer's representative. Do not use installed fire protection specialties as work surfaces.

C. Remove protection when it's no longer needed and before Substantial Completion.

END OF SECTION

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SECTION 10 51 13 – METAL LOCKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Metal lockers.
   2. Locker benches.
   3. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

1.2 REFERENCES

A. Definitions:
   1. Manufacturer: Means the locker manufacturer, unless otherwise indicated.

1.3 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data: Submit manufacturer's product data, specifications, typical installation details, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs), and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
   2. Shop Drawings: Include project-specific dimensioned details drawn to scale showing conditions not detailed on the product data; or that are detailed, but not in a manner specific to the project.

B. Informational Submittals: Submit manufacturer's instructions for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
   1. Submit manufacturer-prepared published instructions for proper installation of furnished lockers.
   2. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.
   3. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.

1.4 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
   1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
   2. Reject items that are not transported, delivered, or protected in conformance with manufacturer-recommended transport, delivery, and receiving requirements.
   3. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items indoors as shipped, upright in their original packaging or containers, within dry, well-ventilated, broom-cleaned and enclosed storage areas.

C. Handling: Handle items in conformance with manufacturer's instructions and other requirements and recommendations, and in a manner that that prevents damage. Avoid damage to packaging and containers, and contamination of contents.

D. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective lockers with undamaged new lockers that do not exhibit deterioration, damage, or defects.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide products manufactured by one of the following, or equal.
   1. Global Industrial.
   2. Lyon Metal Products, Inc.
   3. Penco Products.
   4. Republic Storage Systems Co., Inc.

2.2 METAL LOCKERS

A. Products: "Vanguard Metal Lockers" manufactured by Penco Products, or equal.

B. Requisite Properties:
   1. Configuration: Indicated on the Drawings or selected by the Architect.
   2. Dimensions: Indicated on the Drawings or selected by the Architect.
   3. Door Frames: Welded and reinforced door frames.
   4. Handle: Easy-grip recessed handle.
   5. Locking: Padlock friction hasp.

6. Accessible Lockers: ADA locker modifications include added shelf 9 inches off the floor, ADA-compliant hinge that allows the door to open 180 degrees, ADA locker tag, and ADA-compliant latch and locking hardware that do not require twisting, pinching, or grasping to operate.
7. Finish: Manufacturer's standard baked-enamel finish
8. Color: Indicated on the Drawings or selected by the Architect.

C. Components:
1. Frames: At least 0.0598-inch BMT (MSG 16), one-inch face width channel shapes formed into continuous vertical door strike integral with the frame on both sides of the door opening; and lapped and factory welded corners with top and bottom main frames factory welded into vertical main frames.
2. Doors: At least 0.0598-inch BMT (MSG 16) formed with a full channel shape on the lock side to fully conceal the lock bar, on the hinge side and at right angles across the top and bottom.
   a. Stiffeners: Manufacturer's standard full-height stiffener fabricated from 0.0478-inch BMT (MSG 18) steel sheet and welded to inner face of doors.
   b. Vent: Provide stamped louvers at the top and bottom of each door.
3. Recessed Door Handle and Latch: Pry- and vandal-resistant stainless-steel recessed cup with integral door pull; locking device does not protrude beyond face of door.
   a. Latch: One-piece, pre-lubricated, spring steel latch completely contained within the lock bar under tension to provide rattle-free operation. Provide 2 latch points on heavy-gage frame hooks with rubber silencers.
   b. Handle: Lift type, formed of chrome-plated zinc alloy or steel members. Provide handles that are free of openings or surfaces that permit leverage to be applied.
   c. Locking Mechanism: Provide digital lock.
4. Hinge: 2-inch high, 5-knuckle, full loop, tight pin style hinges securely welded to frame and double riveted to the inside of the door flange.
   a. Provide at least 2 hinges.
   b. Fabricate hinges to swing 180 degrees.
   c. Hinge doors in the direction shown on the Drawings.
5. Body and Shelves: At least 0.0239-inch BMT (MSG 24) un-perforated steel sheet assembled by riveting or bolting body components together.
   a. Flange tops, bottoms and shelves on all 4 sides
   b. Flange backs on 2 sides.
   c. Offset uprights at the front and flange at the rear to provide a double lapped rear corner.
6. Legs: 6 inches high; formed by extending vertical frame members or fabricated from 0.0747-inch BMT (MSG 14) steel sheet; weld to bottom of locker.
7. Closed Front and End Bases: At least 0.0359-inch BMT (MSG 20) steel sheet.
8. Continuous Sloping Tops: At least 0.0359-inch BMT (MSG 20) steel sheet.
9. Hooks: Provide 1 double-prong back hook and two single prong wall hooks at each compartment.

10. Number Plates: Polished aluminum number plate attached to door face with black numerals not less than 1/2-inch high.
11. Coat Hooks: Manufacturer's standard, mounted to bottom of shelf or divider, one per door opening.
12. Provide one locker in each locker room that meets ADA accessibility requirements.

2.3 LOCKER BENCHES

A. Manufacturers: Provide locker benches manufactured by the same manufacturer as the lockers.

B. Bench Tops:
   1. Description: Manufacturer's standard one-piece units, with rounded corners and edges.
   2. Material: Laminated maple with one coat of clear sealer on all surfaces, and 3 coats of clear lacquer on top and sides.
   3. Accessible Bench Size: 42-inches wide by 20 inches deep by 17 inches high.

C. Fixed Pedestals: Manufacturer's standard supports, with predrilled fastener holes for attaching bench top and anchoring to floor, complete with fasteners and anchors, and as follows:

D. Tubular Steel:
   1. Material: 1-1/4-inch diameter steel tubing with at least 0.1345-inch BMT (MSG 10) steel flanges welded at top and base having predrilled fastener holes for attaching bench top and anchoring to floor.
   2. Finish: Manufacturer's standard baked-enamel finish matching adjacent lockers.

2.4 ACCESSORIES

A. Fastenings: Provide backings, inserts, loose connection hardware, fasteners, anchors, attachments, connectors, and other items supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

B. Other Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification: Verify in-place supporting and adjacent construction conforms to the manufacturer's requirements or recommendations and satisfies all other conditions that might affect the quality of installation or the durability, appearance, or performance of installed and adjacent items.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.
   2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 INSTALLATION

A. General Requirements:
   1. Install lockers using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
   2. Set items true to line, to required levels and lines, and plumb, level, and square, without warp or rack, with flush well-fitted joints, and in alignment with adjacent construction
   3. Installed lockers must be warrantable. Do not install, correct, or replace lockers in a manner that results in any warranty or guarantee becoming void.

B. Interface with Adjacent Items: Provide materials, components, and accessories normally furnished or necessary to securely attach lockers to supporting construction.

C. Installation Tolerances: Install lockers to an allowable tolerance variation of not more than 1/4-inch from true position and not more than 1/8-inch from plumb, level, and alignment.

3.3 ADJUSTING

A. Verify smooth and quiet locker door and hardware operation.

B. Lubricate and adjust operating parts and hardware to function properly, free from warp, twist, binding, and distortion. Confirm latches and locks engage securely without forcing or binding.

C. Replace items that do not operate freely in a safe and reliable manner.

3.4 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
   1. written descriptions of non-conforming, damaged, and defective work;
   2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
   3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.5 CLEANING

A. Cleaning Work: Clean all visible locker and bench surfaces in a manner that does not result in any warranty or guarantee becoming void.
   1. Use cleaning materials, equipment, and accessories supplied, and means, methods, techniques, and procedures required, recommended, or accepted by the manufacturer.
   2. Do not use cleaning materials or procedures known to change, or that might change, the appearance of exposed finishes or adjacent surfaces; or cause deterioration or damage to exposed finishes or adjacent surfaces.
   3. Protect adjacent surfaces not being cleaned from staining, deterioration, damage, or other detrimental effects caused by cleaning.
   4. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be cleaned to the Architect's acceptance.

B. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

3.6 PROTECTION

A. Protect installed lockers and benches in place from soiling, deterioration, and damage until Substantial Completion.

B. Do not store anything on or adjacent to or against installed lockers and benches unless they are protected from damage, as accepted in writing by the manufacturer's representative. Do not use installed lockers and benches as work surfaces.

C. Remove protection when it's no longer needed and before Substantial Completion.

END OF SECTION

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DIVISION 11

EQUIPMENT

SECTION 11 31 10 – KITCHENETTE APPLIANCES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Kitchenette appliances.
   2. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

1.2 REFERENCES

A. Definitions:
   1. Manufacturer: Means the appliance manufacturer, unless otherwise indicated.

1.3 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data: Submit manufacturer's product data, specifications, typical installation details, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs), and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
   2. Submit sample warranties with warranty periods, terms, conditions, exclusions, and remedies explicitly defined for each warranty, including clear warranty period start dates. (e.g., date of manufacture, purchase, installation, Beneficial Occupancy, Substantial Completion, Final Completion, etc.)

B. Informational Submittals: Submit manufacturer's instructions for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
   1. Submit manufacturer-prepared published instructions for proper installation of furnished appliances.
   2. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.
   3. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.

C. Closeout Submittals: Submit the following to the Architect as a condition of project closeout.
   1. Warranty Documentation: Submit final warranties signed by the manufacturer's representative with complete terms indicated for all warranties covering items furnished or installed under this specification section.

1.4 QUALITY ASSURANCE

A. Source Limitations:
   1. Appliances must be obtained through one source from the same manufacturer (to ensure compatibility, regulatory conformance, and a warrantable installation).
      a. Certain items may be obtained from more than one manufacturer, but only when used for separate installations.
      b. Items provided for each different installation must be obtained from the same source and manufacturer.
   2. Provide secondary materials, components, accessories and other items from sources required, recommended, or accepted by the primary manufacturer for actual in-service conditions applicable to the project.
   3. All appliances must be Energy-Star Rated.
   4. Equal products and substitutions must match dimensions of appliances indicated, and be submitted for Architect's approval with documentation evidencing that proposed appliance dimensions are not larger than those indicated.

1.5 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
   1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
   2. Reject items that are not transported, delivered, or protected in conformance with manufacturer-recommended transport, delivery, and receiving requirements.
   3. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items indoors as shipped, upright in their original packaging or containers, within dry, well-ventilated, broom-cleaned and enclosed storage areas.

C. Handling: Handle items in conformance with manufacturer's instructions and other requirements and recommendations, and in a manner that that prevents damage. Avoid damage to packaging and containers, and contamination of contents.

D. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective appliances with undamaged new appliances that do not exhibit deterioration, damage, or defects.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

1.6 WARRANTY

A. Manufacturer Warranty: Furnish to the Owner a written manufacturer warranty for products, components, and accessories against all patent and latent defects, and incipient and catastrophic failure for 5 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide product manufactured by one of the following, or equal.
   1. Frigidaire.
   2. GE Appliances.
   3. KitchenAid.

2.2 KITCHENETTE APPLIANCES

A. Refrigerator:
   1. Product: “FFHT1831Q S” manufactured by Frigidaire, or equal.
   2. Requisite Properties:
      a. Height: 66-1/8 inches.
      b. Width: 30 inches.
      c. Depth: 29-7/8 inches.
      d. Capacity: 18 cubic feet.
      e. Finish: Stainless steel.

B. Undercounter Refrigerator:
   1. Product: “True Undercounter Refrigerator” manufactured by TRUE Refrigeration, or equal.
   2. Requisite Properties:
      a. Size: 24 inches wide.
      b. Capacity: 5.6 cubic feet.
      c. Finish: Stainless steel.

C. Microwave Oven: Indicated on the Drawings or selected by the Architect or equal.

D. Dishwasher:
   1. Product: “FDB2410HIC” manufactured by Frigidaire, or equal.
   2. Requisite Properties:
      a. Height : 32-1-2 to 34-7/8 inches (adjustable).
      b. Width: 24 inches.
      c. Depth: 23 inches.

d. Finish: Stainless steel.

2.3 ACCESSORIES

A. Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification: Verify in-place supporting and adjacent construction conforms to the manufacturer's requirements or recommendations and satisfies all other conditions that might affect the quality of installation or the durability, appearance, or performance of installed and adjacent items.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.
   2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 INSTALLATION

A. General Requirements:
   1. Install appliances using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
   2. Set items true to line, to required levels and lines, and plumb, level, and square, and in alignment with adjacent construction
   3. Installed appliances must be warrantable. Do not install, correct, or replace appliances in a manner that results in any warranty or guarantee becoming void.

B. Interface with Adjacent Items: Provide materials, components, and accessories normally furnished or necessary to securely attach appliances to supporting construction and to safely connect facility services.

C. Installation Tolerances: Install appliances to an allowable tolerance variation of not more than 1/4-inch from true position and not more than 1/8-inch from plumb, level, and alignment.

3.3 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
   1. written descriptions of non-conforming, damaged, and defective work;
   2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
   3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.4 CLEANING

A. Cleaning Work: Clean all visible appliance surfaces in a manner that does not result in any warranty or guarantee becoming void.
   1. Use cleaning materials, equipment, and accessories supplied, and means, methods, techniques, and procedures required, recommended, or accepted by the manufacturer.
   2. Do not use cleaning materials or procedures known to change, or that might change, the appearance of exposed finishes or adjacent surfaces; or cause deterioration or damage to exposed finishes or adjacent surfaces.
   3. Protect adjacent surfaces not being cleaned from staining, deterioration, damage, or other detrimental effects caused by cleaning.
   4. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be cleaned to the Architect's acceptance.

3.5 PROTECTION

A. Protect installed appliances in place from soiling, deterioration, and damage until Substantial Completion.

B. Do not store anything on or adjacent to or against installed appliances unless they are protected from damage, as accepted in writing by the manufacturer's representative. Do not use installed appliances as work surfaces.

C. Remove protection when it's no longer needed and before Substantial Completion.

END OF SECTION

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DIVISION 12

FURNISHINGS

SECTION 12 24 13 – ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Roller window shades.
   2. Shade operation.
   3. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

1.2 REFERENCES

A. Definitions:
   1. Manufacturer: Means the window shade manufacturer, unless otherwise indicated.

1.3 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data: Submit manufacturer's product data, specifications, typical installation details, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs), and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
   2. Shop Drawings: Include project-specific dimensioned details drawn to scale showing conditions not detailed on the product data; or that are detailed, but not in a manner specific to the project.
   3. Samples: Submit at least 8-inch square representative samples of each window shade shadecloth color, finish, and variety.

B. Informational Submittals: Submit the following for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
   1. Manufacturer's Instructions: Submit manufacturer-prepared published instructions for proper installation of furnished window shades.
      a. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.

b. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.

2. Qualification Statements: Submit written descriptions confirming experience specified in QUALITY ASSURANCE article below.

1.4 QUALITY ASSURANCE

A. Source Limitations:

1. Window shades must be obtained through one source from the same manufacturer (to ensure compatibility, regulatory conformance, and a warrantable installation).
   a. Certain items may be obtained from more than one manufacturer, but only when used for separate installations.
   b. Items provided for each different installation must be obtained from the same source and manufacturer.
2. Provide secondary materials, components, accessories and other items from sources required, recommended, or accepted by the primary manufacturer for actual in-service conditions applicable to the project.

1.5 HANDLING

A. Receiving and Inspection: Inspect all deliveries for deteriorated, damaged, and defective items. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers. Reject items that are not transported, delivered, or protected in conformance with manufacturer-recommended transport, delivery, and receiving requirements.

B. Unloading: With minimum handling, unload and store only inspected and accepted items.

C. Storage: Store unloaded items as shipped, upright in their original packaging or containers, indoors within dry, well-ventilated, broom-cleaned, and partially- or permanently-enclosed storage areas.

D. Damaged Item Replacement: Promptly remove and replace items that are deteriorated, damaged, or defective with undamaged new items that do not exhibit deterioration, damage, or defects.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

1.6 WARRANTY

A. Manufacturer Warranty: Furnish to the Owner a written manufacturer warranty for products, components, and accessories against all patent and latent defects, and incipient and catastrophic failure for 5 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide products manufactured by one of the following, or equal.
   1. Draper, Inc.
   2. Lutron Electronics Co., Inc
   3. MechoShade Systems, Inc.

2.2 ROLLER WINDOW SHADES

A. Products: Provide products manufactured by MechoShade Systems, Inc., or equal.

B. Requisite Properties:
   1. Model: Indicated on the Drawings or selected by the Architect, or equal.
   2. Sunscreen Shadecloth: “ThermoVeil 1300 Series”, or equal.
      a. Material: 75 percent PVC (coating), 25 percent polyester (yarn).
      b. Size: Fabric width to match window mullion spacing.
      c. Minimum Thickness: At least 30 mils.
      d. Total Weight: 13.5 ounces per square yard.
      e. Openness Factor: 3 percent open.
      f. Color: Indicated on the Drawings or selected by the Architect.
      g. Pattern: Basket weave.
      h. Bottom Hem: Straight.
      i. Maximum Total Solar Energy Transmitted: (Ts) not more than 4.
      j. Minimum Total Solar Energy Reflected: (Rs) at least 5.
      k. Minimum Total Solar Energy Absorbed: (As) at least 91.
      l. Minimum Visible Light Transmitted: (Tv) at least 4.
   3. Blackout Shadecloth: “Classic Blackout 0700 Series”, or equal
      a. Material: 75 percent PVC (coating), 25 percent polyester (yarn).
      b. Size: Fabric width to match window mullion spacing.
      c. Minimum Thickness: At least 32 mils.
      d. Total Weight: 17.6 ounces per square yard.
      e. Openness Factor: 0 percent open.
      f. Color: Indicated on the Drawings or selected by the Architect.
      g. Pattern: Tightly-woven linear weave.
      h. Bottom Hem: Straight.
   4. Mounting: Ceiling mounting permitting easy removal and replacement without damaging roller shade or adjacent surfaces and finishes.
   5. Direction of Roll: Regular or reverse roll.
   6. Operation: Manual operation.

C. Performance Requirements:
   1. Fire Resistance: Provide shade fabrics tested in conformance with NFPA 701, small scale Vertical Burn Test, and rated “PASS”.
   2. Toxicity: Provide shade fabrics tested in accordance with University of Pittsburgh Toxicity Protocol including LC50 analysis and toxicity characteristics.
   3. Anti-Microbial: ASTM G 21 results indicating “No Growth”; ASTM G 22 results indicating minimum 0.197-inch “No Growth Contact Area”.

2.3 COMPONENTS

A. Rollers: Either electro-galvanized or epoxy-primed steel, or extruded-aluminum tube of diameter and wall thickness required to support and fit internal components of operating system and the weight and width of shade band material without sagging; designed to be easily removable from support brackets; with removable spline fitting integral channel in tube for attaching shade material. Provide capacity for one roller shade band(s) per roller, unless otherwise indicated.

B. Mounting Brackets: Fascia end caps, fabricated from steel finished to match fascia or headbox.

C. Fascia: L-shaped, formed-steel sheet or extruded aluminum; long edges returned or rolled; continuous panel concealing front and bottom of shade roller, brackets, and operating hardware and operators; length as indicated; removable design for access.

D. Top/Back Cover: L-shaped; material and finish to match fascia; combining with fascia and end caps to form a six-sided headbox enclosure sized to fit shade roller and operating hardware inside.

E. Pocket-Style Headbox: U-shaped, formed-steel sheet or extruded aluminum; long edges returned or rolled; with a bottom cover consisting of slot opening of minimum dimension to allow lowering and raising of shade and a removable or an openable, continuous metal access panel concealing shade roller, brackets, and operating hardware and operators within.

F. Bottom Bar: Steel or extruded aluminum. Provide concealed, by pocket of shade material, internal-type bottom bar with concealed weight bar as required for smooth, properly balanced shade operation.

G. Hold-Down Brackets and Hooks or Pins: Manufacturer's standard for anchoring roller shade bottom in place and keeping shade band material taut.

2.4 SHADE OPERATION

A. Manual Shade Operation:
   1. Lift-Assist Mechanism: Manufacturer's standard spring assist for balancing roller shade weight and lifting heavy roller shades.

2. Loop Length: Continuous-loop bead-chain with loop length equal to full length of roller shade.
3. Bead Chain: Stainless steel.

2.5 ACCESSORIES

A. Fastenings: Provide backings, inserts, loose connection hardware, fasteners, anchors, attachments, connectors, and other items supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

B. Other Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification: Verify in-place supporting and adjacent construction conforms to the manufacturer's requirements or recommendations and satisfies all other conditions that might affect the quality of installation or the durability, appearance, or performance of installed and adjacent items.

C. Evaluation and Assessment:
1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.
2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 INSTALLATION

A. General Requirements:
1. Install window shades using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
2. Set items true to line, to required levels and lines, and plumb, level, and square, without warp or rack, with flush well-fitted joints, and in alignment with adjacent construction

3. Installed window shades must be warrantable. Do not install, correct, or replace window shades in a manner that results in any warranty or guarantee becoming void.

B. Interface with Adjacent Items: Provide materials, components, and accessories normally furnished or necessary to securely attach window shades to supporting construction.

C. Installation Tolerances: Install window shades to an allowable tolerance variation of not more than 1/4-inch from true position and not more than 1/8-inch from plumb, level, and alignment.

3.3 ADJUSTING

A. Verify smooth and quiet window shade operation.

B. Lubricate and adjust operating parts and hardware to function properly, free from warp, twist, binding, and distortion. Confirm latches and locks engage securely without forcing or binding.

C. Replace items that do not operate freely in a safe and reliable manner.

3.4 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
   1. written descriptions of non-conforming, damaged, and defective work;
   2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
   3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect’s acceptance.

3.5 PROTECTION

A. Protect installed window shades in place from soiling, deterioration, and damage until Substantial Completion.

B. Do not store anything on or adjacent to or against installed window shades unless they are protected from damage, as accepted in writing by the manufacturer's representative.

C. Remove protection when it's no longer needed and before Substantial Completion.

END OF SECTION

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SECTION 12 36 63 – SOLID SURFACE MATERIAL COUNTERTOPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Solid surfacing countertops.
   2. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

1.2 REFERENCES

A. Definitions:
   1. Manufacturer: Means the solid surfacing manufacturer, unless otherwise indicated.
   2. Fabricator: Means the countertop fabricator, unless otherwise indicated.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Scheduling:
   1. Acclimation: Allow sufficient time in the construction schedule to acclimate countertops to specified ambient conditions for between 72 hours and 6 weeks before installation begins, or until moisture content is not more than 8 percent, when measured with a moisture meter at specified ambient conditions.

1.4 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data:
      a. Submit manufacturer's product data, specifications, typical installation details, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs), and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
      b. Submit sample warranties with warranty periods, terms, conditions, exclusions, and remedies explicitly defined for each warranty, including clear warranty period start dates. (e.g., date of manufacture, purchase, installation, Beneficial Occupancy, Substantial Completion, Final Completion, etc.)
   2. Shop Drawings:

a. Submit dimensioned plans drawn to scale and showing countertop layout and types. Show locations, sizes, and extents of all items, accessories, and trim. Label manufactured items by product name.
b. Include project-specific dimensioned details drawn to scale showing profiles, shapes, joints, seams, and dimensions, including coves, miters, and corner conditions. Cross-reference details to plans.
c. Indicate method of attaching, fastening, joining, adhering, and anchoring to adjacent construction.

3. Samples: Submit at least 8-inch square representative samples of each solid surfacing color, finish, and variety.

B. Informational Submittals: Submit written descriptions confirming experience specified in QUALITY ASSURANCE article below for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).

C. Closeout Submittals:
1. Maintenance Data: Submit copies of manufacturer's instructions and other requirements and recommendations for countertop maintenance, cleaning, and repair to the Architect as a condition of project closeout.
2. Warranty Documentation: Submit final warranties signed by the manufacturer's representative with complete terms indicated for all warranties covering items furnished or installed under this specification section.

1.5 QUALITY ASSURANCE

A. Source Limitations:
1. Countertops must be obtained through one source from the same manufacturer (to ensure compatibility, regulatory conformance, and a warrantable installation).
a. Certain items may be obtained from more than one manufacturer, but only when used for separate installations.
b. Items provided for each different installation must be obtained from the same source and manufacturer.
2. Provide secondary materials, components, accessories and other items from sources required, recommended, or accepted by the primary manufacturer for actual in-service conditions applicable to the project.

B. Quality Standards:
1. Fabrication Standard: Provide countertops conforming to Architectural Woodwork Institute/ Architectural Woodwork Manufacturer's Association of Canada/ Woodwork Institute publication "*Architectural Woodwork Standards*" requirements for each specified Grade.

C. Qualifications:

1. Manufacturer: Company or individuals must have at least 10 years' experience manufacturing countertop material installed on at least 200 previous projects similar to this project in size, material, design, and complexity.
2. Fabricator: Company or individuals must have at least 10 years' experience fabricating countertops installed on at least 100 previous projects similar to this project in size, material, design, and complexity
3. Installer: Company or individuals must have at least 5 years' experience installing countertops for at least 30 previous projects similar to this project in size, material, design, and complexity.
4. Supervisors: Individuals must have at least 7 years' experience installing countertops for at least 30 previous projects similar to this project in size, material, design, and complexity, including at least 2 years' supervisory experience directing and leading countertop installers.

1.6 HANDLING

A. Receiving: Inspect all deliveries for deteriorated, damaged, and defective items.
   1. Reject items that are not packaged in a manner that prevents damage; or that exhibit deterioration or damage or have damaged or open packaging or containers.
   2. Reject items that are not transported, delivered, or protected in conformance with manufacturer-recommended transport, delivery, and receiving requirements.
   3. Unload and store only inspected and accepted items.

B. Storage: Store unloaded items indoors as shipped, upright in their original packaging or containers, within dry, well-ventilated, broom-cleaned and enclosed storage areas.
   1. Furnish adequate dunnage and bracing during storage.
   2. Prevent stored items from contacting the floor, from soiling and staining, and from deterioration and damage.
   3. Do not leave items uncovered where they might be exposed to weather or become wet; or exposed to heat or sudden changes in temperature or relative humidity; or other sources of deterioration and damage, including dust and other airborne contaminants.

C. Handling: Handle items in conformance with manufacturer's instructions and other requirements and recommendations, and in a manner that that prevents damage. Avoid damage to packaging and containers.

D. Damaged Item Replacement: Promptly remove and replace deteriorated, damaged, or defective countertops with undamaged new countertops that do not exhibit deterioration, damage, or defects.

E. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

1.7 WARRANTY

A. Manufacturer Warranty: Furnish to the Owner a written manufacturer warranty for products and accessories against all patent and latent defects, and incipient and catastrophic failure for 5 years.

PART 2 - PRODUCTS

2.1 SOLID SURFACING MATERIAL

A. Description: Cast, nonporous, filled polymer; not coated, laminated, or of composite construction; with through body colors conforming to ANSI Z124.3 or ANSI Z124.6.

B. Products: “Corian” solid surfacing by E. I. du Pont de Nemours and Company (DuPont), or equal.

C. Requisite Properties:
   1. Resin: Acrylic.
   2. Thickness: 1/2-inch.
   3. Color and Finish: Indicated on the Drawings.
   4. Reparability: Superficial damage to a depth of 0.010 inch must be repairable by sanding and/or polishing.

2.2 ACCESSORIES

A. Adhesive: Structural-grade silicone or epoxy adhesives of type recommended or accepted by manufacturer for conditions of use. Tint adhesive visible in finished work to match countertop materials.

B. Mounting Spacers: Supplied, required, recommended, or accepted by the adhesive manufacturer, if required.

C. Sealant:
   1. Description: White or clear, medium or high modulus, mildew-resistant silicone sealant conforming to ASTM C 920 requirements for Type S, Grade NS, Class 25, Use NT, A or O sealant, as applicable.
   2. Products: “786” manufactured by Dow Corning Corp., or “Sanitary SCS 1700” manufactured by Momentive Performance Materials, Inc., or equal.

D. Solvent: Supplied, required, recommended, or accepted by the manufacturer to clean countertop surfaces to ensure adhesion of adhesives and sealants.

E. Cleaning Agents: Provide non-abrasive cleansers supplied, required, recommended, or accepted by the manufacturer.

F. Other Accessories: Provide accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

2.3 FABRICATION

A. Shop-fabricate countertops to sizes and shapes indicated on the Drawings and in largest sections practicable to minimize field jointing.

B. Fabricate exposed work precise, straight, and true to line, size, and shape; square and within allowable tolerances; and with accurate angles and surfaces, and crisp straight edges.

C. Cut, drill, and punch countertops as required to receive other components, accessories, hardware, and similar items, and as required to securely attach to supporting construction. Provide openings and similar features as needed to accommodate adjacent work.

D. Carefully inspect finished units at the shop for conformance to specified requirements for appearance, material, and fabrication. Replace defective units.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification: Verify in-place supporting and adjacent construction conforms to the manufacturer's requirements or recommendations and satisfies all other conditions that might affect the quality of installation or the durability, appearance, or performance of installed and adjacent items.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.
   2. Perform or arrange and pay costs without reimbursement from Owner for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 INSTALLATION

A. General Requirements:

1. Install countertops using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
2. Set items true to line, to required levels and lines, and plumb, level, and square, without warp or rack, with flush well-fitted joints, and in alignment with adjacent construction
3. Perform drilling and fitting as required or necessary for an accurate fit and complete installation.
4. Installed countertops must be warrantable. Do not install, correct, or replace countertops in a manner that results in any warranty or guarantee becoming void.

B. Special Techniques:
1. Shim as required using concealed shims.
2. Scribe and fit accurately against adjacent surfaces for a close fit.
3. Attach countertops securely to supports with concealed screws as required for a rigid and secure installation.
4. Seal interface of countertops with contiguous surfaces with sealant.

C. Interface with Adjacent Items: Provide materials, components, and accessories normally furnished or necessary to securely attach countertops to supporting construction.

D. Installation Tolerances: Install countertops to an allowable tolerance variation of not more than 1/4-inch from true position and not more than 1/8-inch from plumb, level, and alignment.

3.3 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
1. written descriptions of non-conforming, damaged, and defective work;
2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be corrected or repaired to the Architect’s acceptance.

3.4 CLEANING

A. Cleaning Work: Clean all visible surfaces in a manner that does not result any warranty or guarantee becoming void.
   1. Use cleaning materials, equipment, and accessories supplied, and means, methods, techniques, and procedures required, recommended, or accepted by the manufacturer.
   2. Do not use cleaning materials or procedures known to change, or that might change, the appearance of exposed finishes or adjacent surfaces; or cause deterioration or damage to exposed finishes or adjacent surfaces.
   3. Protect adjacent surfaces not being cleaned from staining, deterioration, damage, or other detrimental effects caused by cleaning.
   4. Arrange and pay costs without reimbursement from Owner for removing and replacing work that cannot be cleaned to the Architect's acceptance.

B. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

3.5 PROTECTION

A. Protect installed countertops in place from deterioration, and damage until Substantial Completion.

B. Do not store anything on, adjacent to, or against installed countertops unless they are protected from damage, as accepted in writing by the manufacturer's representative. Do not use installed countertops as work surfaces.

C. Remove protection when it's no longer needed and before Substantial Completion.

END OF SECTION

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DIVISION 13

SPECIAL CONSTRUCTION

SECTION 13 49 13 – INTEGRATED X-RAY SHIELDING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Lead glass.
2. Lead-lined gypsum board.
3. Lead-lined steel door frames.
4. Lead-lined wood doors.
5. Lead-lined observation-window frames.
6. Floor lead.
7. Supplementary components and accessories normally furnished or necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

1.2 REFERENCES

A. Definitions:
1. Manufacturer: Means the shielding manufacturer, unless otherwise indicated.
2. Lead Equivalence: Means the thickness of lead that gives the same attenuation (reduction of radiation passing through) as the material in question under the specified conditions. Lead equivalence specified for materials used in diagnostic x-ray rooms is as measured at 100 kV, unless otherwise indicated.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Materials, thicknesses, and configurations indicated are based on radiation protection design prepared by the Owner's radiation health physicist. This design is available by request.

B. Performance Requirements:
1. Provide materials and workmanship that maintain continuity of radiation protection at all points and in all directions equivalent to the materials specified in thicknesses and locations indicated, including joints, seams, and all penetrations.
2. Lead-Lined Assemblies: Unless otherwise indicated, provide lead thickness in doors, door frames, window frames, penetration shielding, joint strips, film transfer cabinets, and other items located in lead-lined assemblies equivalent to at least that indicated for assemblies in which they are installed.
3. Lead Glazing: Unless otherwise indicated, provide lead equivalence of at least that indicated for the assemblies in which glazing is installed.

C. Sequencing: Floor lead installation must be installed prior to finish flooring, cabinetry, or equipment installation.

1.4 SUBMITTALS

A. Action Submittals: Submit the following for responsive action (formal review and approval).
   1. Product Data: Submit manufacturer's product data, specifications, typical installation details, and all other information necessary to show conformance to the Contract Documents, excluding material safety data sheets (MSDSs), and safety data sheets (SDSs), both of which are returned to the Contractor without review or responsive action.
   2. Shop Drawings:
      a. Submit dimensioned plans and elevations drawn to scale and showing layout of radiation-protected areas and shielding layout, lead thickness or lead equivalence, joints, edge conditions, and finishes. Show locations, sizes, and extents of all items, accessories, and trim. Label manufactured items by product name.
      b. Show ducts, pipes, conduit, and other objects that penetrate radiation protection together with penetration details.
      c. Show door and frame details, including anchorage to and coordination with other work. Show locations of electrical conduit and boxes for connecting door operators, door operator switches, and door interlock switches.
      d. Include project-specific dimensioned details drawn to scale showing shielding attachment to supporting construction; and other conditions not detailed on the product data; or that are detailed, but not in a manner specific to the project. Cross-reference details to plans and elevations.

B. Informational Submittals: Submit the following for information (informal review: responsive action not expected or required, except to record non-conformance with submittal requirements).
   1. Manufacturer's Instructions: Submit manufacturer-prepared published instructions for proper installation of furnished shielding.
      a. If manufacturer's instructions are unavailable or do not apply to specific project conditions, then consult the manufacturer's representative and obtain project-specific supplemental instructions printed on manufacturer's letterhead.
      b. Promptly distribute supplemental instructions to the Architect, who may have comments that lead to contract modifications or minor changes in the work.

C. Closeout Submittals: Submit the following to the Architect as a condition of project closeout.
   1. Maintenance Data: Submit copies of manufacturer's instructions and other requirements and recommendations for shielding maintenance, cleaning, and repair.

1.5 QUALITY ASSURANCE

A. Source Limitations: Shielding must be obtained through one source from the same manufacturer (to ensure compatibility, regulatory conformance, and a warrantable installation).
   1. Certain items may be obtained from more than one manufacturer, but only when used for separate installations.
   2. Items provided for each different installation must be obtained from the same source and manufacturer.

1.6 HANDLING

A. Receiving and Inspection: Inspect all deliveries for deteriorated, damaged, and defective items. Reject items that
   1. are not packaged in a manner that prevents damage;
   2. are not transported, delivered, or protected in conformance with manufacturer-recommended transport, delivery, and receiving requirements; or
   3. exhibit deterioration and damage; or that have damaged or open containers.

B. Unloading: With minimum handling, unload and store only inspected and accepted items.

C. Storage: Store unloaded items as shipped, upright in their original containers, and in conformance with manufacturer's instructions and other requirements and recommendations for storage.
   1. Store items indoors within dry, well-ventilated, broom-cleaned, and partially- or permanently-enclosed storage areas; where "wet work" within storage areas (e.g., concrete, cast underlayment, mortaring, grouting, plastering, gypsum board finishing, etc.) is complete and cured or dried to a condition of equilibrium.
   2. Prevent stored items from contacting the floor or ground, from soiling and staining, and from deterioration and damage.

D. Handling: Handle items in conformance with manufacturer's instructions and other requirements and recommendations, and in a manner that that prevents damage.

E. Damaged Item Replacement: Promptly remove and replace items that are deteriorated, damaged, or defective with undamaged new items that do not exhibit deterioration, damage, or defects.

F. Packaging Waste Management: Do not burn or bury construction waste at the project site. Remove and legally dispose of all construction waste away from the project site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide products manufactured by one of the following, or equal.
   1. NELCO Corp.
   2. Radiation Protection Products.
   3. Ray-Bar Engineering Corp.

2.2 MATERIALS

A. Lead Sheet, Strip, and Plate: ASTM B 749, alloy UNS No. L51121. (chemical-copper lead) Assume at least 0.065-inch (nominal 1/16-inch), unless another thickness is indicated on the project physicist report.

B. Lead Glass: Lead-barium polished float glass containing at least 60 percent heavy metal oxides, including at least 48 percent lead oxide by weight. Provide laminated lead glass wherever safety glazing is required.
   1. Applications: Vision panels located in lead-lined partitions and other locations indicated on the drawings.
   2. Thickness: 1-1/4 inch.

2.3 LEAD-LINED GYPSUM BOARD

A. Description: 99.9 percent pure, un-pierced lead sheet conforming to Federal Specification QQ-L-201f, Grade C, factory-laminated under pressure to the back side of a gypsum board complying with ASTM C 1396.

B. Requisite Properties:
   1. Provide lead lining full width and length of board.
   2. Provide 3-inch wide lead strips for wrapping metal stud flanges.
   3. Provide 2-inch wide lead strips for backing joints.

2.4 LEAD-LINED STEEL DOOR FRAMES

A. Description: Steel door frames complying with NAAMM HMMA 861, except 0.0667 inch thick, and lined with lead sheet of thickness at least that required for doors and walls where frames are used.

B. Requisite Properties:
   1. Provide additional reinforcements and internal supports to adequately carry the weight of lead-lined doors. Install reinforcements and supports before installing lead lining.

2. Form lead sheet to match frame contour, continuous in each jamb and across the head, lapping the stops. Form lead shields around areas prepared to receive hardware. Fabricate lead lining wide enough to maintain an effective lap with lead of adjacent shielding.

2.5 LEAD-LINED WOOD DOORS

A. Description: Flush wood doors with lead lining.

B. Manufacturers: Provide products manufactured by one of the following, or equal.
   1. Algoma Hardwoods, Inc.
   2. Eggers Industries.
   3. Marshfield Door Systems, Inc.
   4. Oshkosh Architectural Door Co.

C. Requisite Properties:
   1. Door Construction: Seven ply, bonded structural composite lumber core.
      Facing: Indicated on the Drawings or selected by the Architect, or equal.
   2. Lead Lining: One continuous sheet of lead extending from top to bottom and edge to edge, constructed in the core. Assemble lead lining and core with poured lead fasteners or steel bolts. Space fasteners not more than 1-1/2 inches from door edge and about 8 inches on center. Countersink bolt heads.
   3. Factory fit doors to suit frame openings indicated with 1/16-inch clearance at heads and jambs and minimum clearance at bottom. Factory machine doors for hardware not surface applied.
   4. Shield cutouts for locksets with lead sheet of same thickness used in door. Lap lining of cutouts with door lining.

2.6 LEAD-LINED OBSERVATION-WINDOW FRAMES

A. Description: 0.0428-inch-thick formed-steel sheet or 0.064-inch-thick aluminum extrusions with mitered corners, and wither welded or bolted with concealed fasteners.

B. Requisite Properties:
   1. Line with lead sheet formed to match frame contour, continuous in each jamb and across head and sill, lapping the stops, and fabricated wide enough to maintain an effective lap with lead of adjoining assemblies.
   2. Construct so lead lining overlaps glazing material perimeter by at least 3/8 inch and provide removable stops.
   3. Form sills with an opening for sound transmission. Offset sound passage to make opening lightproof and to maintain required lead equivalence at all points and in all directions.

2.7 ACCESSORIES

A. Fastenings: Provide backings, inserts, loose connection hardware, fasteners, anchors, attachments, connectors, and other items supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

B. Other Accessories: Provide other accessories and secondary items normally furnished or necessary for a complete installation; or supplied, required, recommended, or accepted by the manufacturer for actual in-service conditions applicable to the project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Oversight: Ensure an adequate number of supervisors are present and proper supervision practices are followed at the project site before the installer begins work and at all times during installation.

B. Verification: Verify in-place supporting and adjacent construction conforms to the manufacturer's requirements or recommendations and satisfies all other conditions that might affect the quality of installation or the durability, appearance, or performance of installed and adjacent items.

C. Evaluation and Assessment:
   1. Identify project conditions that do not conform to the manufacturer's instructions and other requirements and recommendations.
   2. Perform or arrange and pay costs for all remedial work necessary to correct or improve deficient conditions, without limitation, before the installer begins work.

3.2 INSTALLATION

A. General Requirements:
   1. Install shielding using materials and methods required, recommended, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
   2. Installed shielding must be warrantable. Do not install, correct, or replace any shielding in a manner that is un-warrantable by the manufacturer; or that results in any other specified or other warranty or guarantee becoming void.

B. Lead-Lined Gypsum Board Special Techniques:
   1. Install with long edge parallel to supports and lead lining facing supports. Install blocking at end joints.
   2. Fastening to Metal Supports: Use steel drill screws spaced as recommended in writing by gypsum-board manufacturer.

3. Install lead strips, 1-1/2 inches wide minimum and same thickness as lead lining, to face of supports and blocking where joints occur.
4. Secure lead strips with construction adhesive.
5. Install shims at intermediate supports.
6. Two-Layer System: Apply gypsum board facing sheet vertically over base sheet using fasteners backed by lead tabs, unless otherwise required, recommended, or accepted in writing by lead-lined gypsum-board manufacturer.
7. Offset joints in finish layer from joints in base layer.
8. Locate fasteners above ceiling or behind wall base.
9. Openings: Extend lead-lined gypsum board into opening frames, lapping lead lining with lead frames or frame linings at least 5/8 inch.
10. Install control and expansion joints with appropriate trim accessories where indicated; or where required, recommended, or accepted in writing by lead-lined gypsum-board manufacturer. Install lead strip on face of framing, extending across joint, and lap with lead lining of gypsum board.

C. Doors and Frame Special Techniques:
1. Install lead-lined steel door frames in compliance with the manufacturer's recommendations or requirements.
2. After lead has been installed, apply a coat of asphalt mastic or paint to lead lining in door frames where lead will come in contact with masonry or grout.
3. Install lead-lined wood doors, unless otherwise indicated.
4. Frames: Comply with NAAMM HMMA 840, unless otherwise indicated. Except for frames located in existing walls or partitions, place frames before constructing walls. Set frames accurately in position, plumb, and brace securely until permanent anchors are set.
5. Install three anchors per jamb, located adjacent to hinge on hinge jamb and at corresponding heights on strike jamb.
6. In masonry construction, use wire or T-strap anchors and apply a coat of asphalt mastic or paint to lead lining where lead will come in contact with masonry or grout.
7. In metal stud construction, use wall anchors attached to studs with screws.
8. Lap lead lining of frames over lining in walls at least 5/8-inch.
9. Lead Lining of Frames: Line inside of frames with lead of thickness at least that required in doors and walls where frames are used. Form lead to match frame contour, continuous in each jamb and across the head, lapping the stops. Form lead shields around areas prepared to receive hardware. Lap lining over lining in walls at least 5/8-inch.
10. Install doors in frames level and plumb, aligned with frames and with uniform clearance at each edge.
11. Line astragals with lead sheet.
12. Hardware: Line covers, escutcheons, and plates to produce effective shielding at cutouts and penetrations of frames and doors. See Division 08 Section "Door Hardware" for other installation requirements.

13. Touch up damaged finishes with compatible coating after sanding smooth.
14. Check and readjust operating hardware items, leaving doors and frames undamaged and in proper operating condition.

D. Penetrating Items Special Techniques:
   1. At penetrations of lead linings, install lead shields to maintain continuity of protection.
   2. Install lead linings, sleeves, shields, and other protection in thickness at least that required in assembly being penetrated.
   3. Secure shields at penetrations using fasteners.
   4. Film Transfer Cabinets: Where film transfer cabinets occur in lead-lined partitions, line wall flange with lead sheet of same thickness as required for partition where it is located.
   5. Outlet Boxes and Conduit: Cover or line with lead sheet lapped over adjacent lead lining at least 1 inch. Where it penetrates both sides of the wall on the same plane, wrap conduit with lead sheet for 10 inches from box.
   6. Duct Openings: Unless otherwise indicated, line ducts with lead sheet for distance from partition/ceiling equal to three times the largest opening dimension. Lap lead sheet with adjacent lead lining at least 1 inch.
   7. Piping: Where it penetrates both sides of the wall on the same plane, wrap piping with lead sheet for 10 inches from point of penetration, unless otherwise indicated.

E. Floor Lead Special Techniques:
   1. Verify floor is prepared, smooth, level, and flat. (lead is not a filler - imperfections will telegraph through)
   2. Verify lead is degreased and free of all oil.
   3. Verify floor is clean and free of all dust or oils. Completely vacuum clean with HEPA vacuum and wet mop.
   4. Use a contact cement or flooring adhesive mastic recommended, approved, or accepted by the floor lead manufacturer or supplier.
   5. Overlap all joints by at least 1/2-inch. Penetrations must be backed with pure sheet lead of same thickness.
   6. Provide good ventilation and fan/exhaust all air to outside of building; away from any occupants in surrounding areas. Utilize a confined space fan with flexible sealed duct tubing exhausting to exterior at a volume of at least 700 cubic feet per minute or greater.
   7. Use protective gloves and dust masks.
   8. Use correct lead handling procedures. (i.e., no eating, drinking or smoking in lead work areas, wash hands after handling, do not cut with power tools, etc.)
   9. Other trades or persons are prohibited from occupying areas or rooms during floor lead installation.
   10. Protect lead from foot traffic tracking.
   11. Use heavy floor roller or hit with block of wood and mallet to set lead flat.

12. Verify compliance with all state, federal or local safety codes, laws, regulations, and requirements.

F. Interface with Other Work: Provide materials, components, and accessories normally furnished or necessary to securely attach shielding to supporting construction.

3.3 FIELD QUALITY CONTROL

A. Site Tests and Inspections:
   1. General: Include site tests and inspections as part of the work of this specification section. The Owner's testing and inspection agency performs tests and inspections.
      a. Schedule and arrange all tests and inspections.
      b. Coordinate all work and the final construction schedule with all tests and inspections.
      c. Coordinate tests and inspections with the work of other specification sections, and other specified, required, or necessary tests and inspections.
      d. Furnish all work, equipment, tools, facilities, personnel, and controls necessary for each test and inspection.
      e. Arrange tests and inspections by notifying the Owner, the testing and inspection agency, the installer, the manufacturer's representative, and the Architect at least 5 business days before work is ready for testing or inspection.
      f. Witness all site tests and inspections.
      g. Receive test and inspection reports and distribute to the installer and the manufacturer's representative.
      h. When tests and inspections reveal defective items, repair defective work to the satisfaction of the manufacturer's representative and Architect, and re-test and re-inspect work without reimbursement from Owner until all work passes tests and inspections.
   2. Required Tests: After radiology equipment is installed and placed in operating condition, the Owner engages a radiation health physicist to test radiation protection.

3.4 CORRECTION AND REPAIR

A. Non-conforming, damaged, and defective work must be brought into conformance with the Contract Documents. Correct and repair as necessary, without limitation, including arranging all correction and repair work and paying all correction and repair costs, and re-inspection and re-testing costs, without reimbursement from Owner, until accepted in writing by the Architect.

B. Corrective and repair work must be performed in conformance with a correction and repair plan submitted to and accepted in writing by the Architect before correction or repair work begins. At a minimum, correction and repair plans must include
   1. written descriptions of non-conforming, damaged, and defective work;

2. supporting sketches, diagrams, photographs, and other visual depictions of non-conforming, damaged, and defective work; and
3. similar written descriptions and visual depictions of Contractor-proposed corrections and repairs.

C. Arrange and pay costs for removing and replacing work that cannot be corrected or repaired to the Architect's acceptance.

3.5 CLEANING

A. Waste Management: After completing the work of this specification section, leave work areas free from debris, waste, scrap, equipment, tools, and other items.

3.6 PROTECTION

A. Protect installed shielding in place from deterioration, and damage until Substantial Completion. Lock radiation-protected rooms once doors and locks are installed and limit access to only those persons performing work in rooms.

B. Do not store anything adjacent to or against installed shielding unless it is protected from damage, as accepted in writing by the manufacturer's representative. Do not use installed shielding as work surfaces.

C. Remove protection when it's no longer needed and before Substantial Completion.

END OF SECTION

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Project Manual

100% Construction Documents

NEW CARDIAC CATHETERIZATION LAB SUITE & HYPERBARIC FACILITY EXPANSION RIVERSIDE UNIVERSITY HEALTH SYSTEM

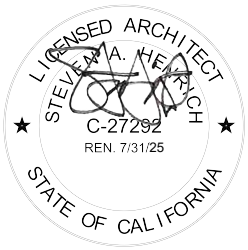
26520 Cactus Avenue
Moreno Valley, CA 92555

HCAI #S231455-33-00

(Package 3 of 4: Sections 22 05 00 thru 23 84 13)

Leo A. Daly
Project No. 047-10071-002
October 10, 2023

SECTION 00 01 07 – SEALS PAGE

 Stamp & Signature of Architect of Record	 Stamp & Signature of Structural Engineer of Record
 Stamp & Signature of Mechanical Engineer of Record	 Stamp & Signature of Electrical Engineer of Record

REVIEWED IN ACCORDANCE WITH
THE REQUIREMENTS OF T24, CCR
APPROVED
Allen Cheng,Senior Architect
August 16, 2024
Department of Health Care Access and Information
FACILITIES DEVELOPMENT DIVISION

DIVISION 22

PLUMBING

SECTION 22 05 00 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Division 07 Section “Penetration Firestopping” for piping, conduit and wiring penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies and smoke barriers.

C. Division 07 "Roof Accessories" and "Sheet Metal Flashing and Trim" for piping, conduit and equipment supports penetrating roofs, exterior walls and floors including flashings, curbs, sealants, clamps and vents.

1.2 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Grout.
5. Flashing Materials.
6. Equipment installation requirements common to equipment sections.
7. Painting and finishing.
8. Concrete bases.
9. Supports and anchorages.

1.3 DEFINITIONS

A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Actual Air: Air delivered at air-compressor outlet. Flow rate is compressed air delivered and measured in ACFM.

C. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. D.I.S.S.: Diameter-index safety system.

F. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

G. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

H. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

I. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

J. High-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures between 150 and 200 psig.

K. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content ≤0.25% per Safe Drinking Water Act NSF 372.

L. Low-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures of 150 psig or less.

M. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

N. LP Gas: Liquefied-petroleum fuel gas.

O. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

P. Standard Air: Free air at 68 deg Fand 1 atmospherebefore compression or expansion and measured in SCFM.

Q. Tepid: Moderately warm.

R. The following are industry abbreviations:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. BR: Butyl rubber.
3. Buna-N: Nitrile rubber.
4. CPVC: Chlorinated polyvinyl chloride plastic.
5. CWP: Cold working pressure;
6. EPDM: Ethylene-propylene-diene terpolymer rubber.
7. FOG: Fats, oils, and grease.
8. FPM: Vinylidene fluoride-hexafluoro propylene copolymer rubber.

9. FRP: Fiberglass reinforced plastic.
10. HDPE: High-density polyethylene plastic.
11. LPG: Liquefied-petroleum gas
12. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
13. NBR: Acrylonitrile-butadiene rubber.
14. NRS: Non-rising stem.
15. OS&Y: Outside screw and yoke.
16. PE: Polyethylene plastic.
17. PP: Polypropylene plastic.
18. PTFE: Polytetrafluoroethylene plastic.
19. PUR: Polyurethane plastic.
20. PVC: Polyvinyl chloride plastic.
21. PVDF: Polyvinylidene fluoride plastic.
22. SWP: Steam working pressure.
23. TFE: Tetrafluoroethylene plastic.
24. TPE: Thermoplastic elastomer.
25. uPVC: Unplasticized Polyvinyl chloride plastic.
26. WAGD: Waste anesthetic gas disposal.

1.4 SCOPE

A. Drawings and Specifications form complementary requirements; provide work specified and not shown, and work shown and not specified as though explicitly required by both. Although work may not be specifically shown or specified, provide supplementary or miscellaneous items, appurtenances, devices and materials obviously necessary for a sound, secure and complete installation.

B. It is the intent that these Specifications and associated Drawings establish minimum requirements for products and equipment with the intent to provide plumbing systems finished, tested and ready for operation. Incidental detail that is not shown or specified, but necessary for proper installation and operation shall be included in the work and in these Contractor's estimates, the same as if specified. Locations of all equipment and material shall be adjusted at no extra cost to the Owner, to accommodate the work interferences anticipated and/or encountered. Prior to installation, determine the exact route and location of each pipe and piece of equipment to minimize conflicts with other trades.

C. This project will be phased, as defined by the Owner. This may necessitate the provision of temporary valving and capping of Plumbing utilities. All associated appurtenances with the utilities shall be provided as part of this project in the appropriate phase coordinated with Owner’s phasing requirements.

D. Information and components shown on riser diagrams but not shown on plans, and vice versa, shall be provided as if expressly required on both.

E. It is the requirement of these Contract Documents to have the contractors provide systems and components that are fully complete, operational and suitable for the intended use.

There may be situations in the documents where insufficient information exists to precisely describe a certain component or subsystem, or the routing of a component or its coordination with other building elements. In cases such as this, where the Contractor has failed to notify the Architect of the situation the Contractor shall include the specific components or subsystems with all parts necessary for the intended use, fully complete and operational, and installed in workmanlike manner either concealed or exposed per the design intent.

1.5 MODIFICATIONS IN LAYOUT

A. Drawings are intended to outline the scope of work required and are not intended to be installation drawings. Drawings are not intended to be absolutely precise; they are not intended to specify or to show every offset, fitting, and component nor do they show the exact routing and locations needed to coordinate with structure and other trades and to meet Architectural requirements. The purpose of the drawings is to indicate a systems concept, the main components of the systems, and the approximate geometrical relationships. Drawings do not necessarily show the exact routings and locations needed to fully coordinate with structure and other trades to meet Architectural requirements. Based on the systems concept, the main components, and the approximate geometrical relationships, the contractor shall provide all other components and materials necessary to make the systems fully complete and operational.

B. Unless specifically stated to the contrary, no measurement of a drawing derived by scaling shall be used as a dimension to work by. Dimensions noted on the drawings are subject to measurements of adjacent and previously completed work. Measurements shall be performed prior to the actual installation of equipment.

C. Prior to installation of visible material and equipment (including access panels) in finished spaces, review Architectural Drawings for desired locations and where not definitely indicated, request information from Architect.

D. Check Contract Documents, as well as, Submittals and Shop Drawings of all subcontractors to verify and coordinate spaces in which work of Divisions 21 through 28 will be installed.

E. Make reasonable modifications in layout and components needed to prevent conflict with work of other trades. Systems shall be run parallel with or perpendicular to major architectural and structural building elements.

F. Where conflicts or potential conflicts exist and engineering guidance is desired, submit sketch of proposed resolution to Architect for review and approval.

1.6 COORDINATION

A. Coordinate arrangement, mounting, and support of piping and equipment:

1. To maintain maximum headroom; all piping, duct, conduit and associated components to be as tight as possible to underside of structure to provide for ease of disconnecting the equipment with minimum interference to other installations.
2. To allow right of way for piping installed at required slope.
3. To be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified by the architect. Locations of access doors are to be shown on coordination drawings and approved by the Architect prior to installation.

1.7 COORDINATION DRAWINGS

A. When included as part of the Contract Documents, there shall be full cooperation and coordination of all specialty trades.

B. This Division's contractors shall comply fully with the requirements set forth in the Division 23 "BIM Coordination Drawings" specification section.

1.8 RECORD DOCUMENTS

A. Record Drawings are specified in Division 01 Section "Project Record Documents."

B. The Contractor shall keep a detailed up-to-date record, of the manner and location in which installations are actually made, indexing pipe, valve, and piece of equipment. Record documents are to reflect all changes in work including change orders, field directives, addenda from bid set of Contract Documents, request for information responses, etc. Upon completion of the project, the contractor shall modify the project electronic drawing and specification files to incorporate this information. Modified documents shall be turned over to the Owner in both electronic and hard paper copy formats. Record drawings shall also include:

1. Locations of buried piping or similar items. Include buried depth.
2. Field changes of dimension or detail.
3. Changes made by field order or change order.
4. Details not on original contract drawings.

1.9 MAINTENANCE MANUALS AND OPERATING INSTRUCTIONS

A. Obtain at time of purchase of equipment, three copies of operation, lubrication and maintenance manuals for all items. Assemble literature in a coordinated manual. Manual shall contain names and addresses of manufacturers and local representatives who stock or furnish repair parts for items or equipment.

B. The manuals shall include the following and shall have an index of contents and tabs for each Specification Section and each piece of equipment specified in that Section and be provided in the order listed below, per Specification Section.

1. Copies of all approved submittals/shop drawings.
2. Manufacturer's operating and maintenance instructions and parts lists of all items or equipment. Where manufacturer's data includes several types or models, the applicable type or model shall be clearly designated.
3. Startup and shutdown procedures.
4. Flow diagrams.
5. Test records.
6. Wiring diagrams.
7. Lubrication instructions detailing type of lubricant, amount, and intervals recommended by manufacturer for each item of equipment.
8. Owner's written acknowledgement of satisfactory completion of instruction period.

C. Furnish three copies of manuals to Architect for approval and distribution to Owner. Deliver manuals no less than 30 days prior to acceptance of equipment to permit Owner's personnel to become familiar with equipment and operation prior to acceptance.

D. Operating instructions: Upon completion of installation or when Owner accepts portions of building and equipment for operational use, instruct Owner's operating personnel in any or all parts of all systems. Factory-trained personnel shall perform instructions.

1.10 SUBMITTAL PROCEDURE AND FORMAT

A. This Article supplements Division 1.

B. Submittal Cover Sheet

1. Submittal data for each product shall include a copy of the following cover sheet completely filled out. Incomplete or incorrect cover sheet submittal shall constitute reason for rejection.
2. Material submittals shall be organized by specification section. All items requiring a submittal per each specification section shall be combined into a single submittal. Provide each section/item within that submittal with its own cover sheet labeled and tagged to match the drawings.

C. Contractor shall submit a schedule specifically indicating which piping material will be utilized in each application.

SHOP DRAWING COVER SHEET				
PROJECT:		CONTRACTOR:		
DIVISION NO.:		SECTION NO.:		
DESCRIPTION:				
CONTRACT DRAWING REFERENCE NO:				
EQUIPMENT TAG:				
SUBMISSION (CIRCLE ONE): FIRST, SECOND, THIRD, FOURTH				
DATE:				
INFORMATION AND CHECKLIST				
1.	Contractor's Log #ID			
2.	Name, address, and phone number of supplier.			
3.	Are all specified or scheduled items included and exactly match scheduled/specified items?	Yes	No	
4.	Is this item a substitution?	Yes	No	
5.	Are deviations clearly identified?	Yes	No	
6.	Does equipment fit space shown on construction documents, coordination drawings, and actual field conditions?	Yes	No	
7.	Has support, erection, weights, and installation been coordinated with all trades?	Yes	No	
8.	Does the proposed installation void warranties and/or violate UL or code requirements?	Yes	No	
9.	Does this material/equipment add expense to any other trade or project costs?	Yes	No	
10.	Does equipment require interface with other trades? List divisions and specifics requiring coordination?	Yes	No	
11.	Is control interface coordinated?	Yes	No	
12.	List electrical characteristics (V/Ph/A)			

D. Multiple Re-submittals: The Engineer will review the first submittal from the contractor and respond with comments, and will review one re-submittal for the same item(s) from the contractor and respond with comments. If the contractor is required to make subsequent submittals for the same item(s) the Engineer shall be compensated by the contractor for the time to review each subsequent re-submittal. The contractor shall agree to compensate the Engineer a minimum of $500 per each re-submittal item.

E. Shop Drawings showing layouts of systems shall contain sufficient plans, elevations, sections, details and schematics to describe work clearly. They shall be 1/4 inches = 1 foot 0 inch scale unless specified otherwise.

F. Shop drawings and submittals showing manufacturer's product data shall contain detailed dimensional drawings, accurate and complete description of materials of construction, manufacturer's published performance characteristics and capacity ratings (performance data, alone, is not acceptable), electrical requirements and wiring diagrams. Drawings shall clearly indicate location (terminal block or wire number), voltage and function for all field terminations, and other information necessary to demonstrate compliance with all requirements of Contract Documents.

G. Provide shop drawing submittals showing details of piping connections to ALL equipment. If connection details are not submitted and connections are found to be installed incorrectly in the field, this contractor shall reinstall them within the original contract price.

H. Shop drawings for different systems and equipment shall be bound separately by specification section as indicated above and not bound by manufacturer. Each separate submittal shall have its own transmittal and cover letter. Submittals which contain different specification section systems bound together may be returned un-reviewed for re-submittal.

1.11 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. All piping materials shall bear label, stamp, or other markings of specified testing agency, including but not limited to Underwriters Laboratory (UL) and the Cast Iron Soil Pipe Institute (CISPI).

D. Electrical Characteristics for Plumbing Equipment: Equipment of different electrical characteristics may be furnished provided such proposed equipment is approved in

writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified at the contractor's expense. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

E. All electrical components, devices and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use. Skid-mounted or packaged assemblies shall be listed and labeled as an assembly, not just the individual components.

F. Fire-Resistance Ratings: Where indicated, provide penetration firestopping devices tested for fire resistance per ASTM E 814 by a testing agency acceptable to authorities having jurisdiction. Indicate design designations from UL's "Fire Resistance Directory."

G. Installer Qualifications:

1. Pressure-Seal Joining Procedure for Copper Tubing: Qualify operators according to training provided by Viega; Plumbing and Heating Systems.
2. Pressure-Seal Joining Procedure for Steel Piping. Qualify operators according to training provided by Victaulic Company.
3. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or to AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
4. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
5. A factory-trained representative shall provide on-site training for the contractor's field personnel in the proper installation of all mechanical type joint products within any piping system. The representative shall periodically visit the job site to ensure best practices in grooved joint installations are being followed. A distributor's representative is not considered qualified to conduct the training

H. NSF Standard: Comply with NSF 61, "Drinking Water System Components – Health Effects," for all components, including piping, equipment, and fixture material that will be in contact with potable water. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.

1. All plumbing components, including but not limited to piping, valves, backflow preventers, fixtures, etc that are connected to the domestic water system which convey water to be used for human consumption shall meet the NSF-372, 'Lead-Free' requirements. Items not intended to dispense water for human consumption such as flush valves, tub fills, shower valves, or piping accessories connected to non-potable water systems, are not required to meet the 'Lead Free' requirements.

I. Acceptable Manufacturers

1. The Engineer's design for each product is based on the manufacturer listed in the schedule or shown on the drawings. In Part 2 of some technical specifications, other manufacturers are listed as being acceptable. The listing of a manufacturer as acceptable does not imply automatic approval. It is the sole responsibility of the

Contractor to ensure that any submittals made are for products that meet or exceed the specifications included herein. These are acceptable only if, as a minimum, they:

a. Meet all performance criteria listed in the schedules and outlined in the specification.
b. Have identical operating characteristics to those called for in the specification. For example, a two-stroke diesel generator will not be acceptable if a four-stroke model is specified.
c. Fit within the available space it was designed for, including space for maintenance and component removal, with no modification to either the space or the product. Clearances to walls, ceilings and other equipment will be at least equal to those shown on the design drawings. The fact that a manufacturer's name appears as acceptable shall not be taken to mean that the Engineer has determined that the manufacturer's products will fit within the available space - this determination is solely the responsibility of the contractor.
d. Products must adhere to all architectural considerations including but not limited to: being of the same color as the product scheduled or specified, fitting within architectural enclosures and details, and for diffusers, lighting and plumbing fixtures - being the same size and of the same physical appearance as scheduled or specified products.
e. All equipment shall be labeled or listed by the National Board of Underwriters Laboratories (U.L.) where such labeling or listing exists for such material.

J. All components within a single plumbing system shall be compatible with one another per the manufacturer(s).

K. All individual components in each plumbing system shall be from a single manufacturer.

1.12 TEMPORARY SERVICES/CONTINUITY OF UTILITY SERVICES

A. In the absence of specific requirements in Division 1, comply with the following procedures for shut-downs.

B. Provide temporary services where project construction schedule requires extended shut downs of existing equipment and/or systems. Temporary services include the necessary equipment and/or systems to maintain continuity of services. Extended shut downs are interruptions of existing services for a period of time longer than that acceptable to the Owner.

C. Contractor shall coordinate any shutdowns of existing systems as follows:

1. Give proper notice to Owner when making shutdowns; a minimum of fourteen full days is required.
2. Minimize timeline of shutdowns of any system.
3. Provide temporary services where required and perform shutdowns and tie-ins at a time convenient to Owner.

4. Contractor shall be responsible for completing and filing the Owner's shutdown notice questionnaire.
5. Perform required survey and inspection work required by the notice for shutdown.
6. All life safety systems shall be returned to service at the end of each work day, when work is being performed on the systems. It is the responsibility of the Contractor to provide all associated appurtenances necessary to ensure that the systems are in proper working condition at all times.

1.13 DELIVERY, STORAGE, AND HANDLING

A. Store ALL plastic piping and valves protected from direct sunlight. Support to prevent sagging and bending.

B. Protect equipment/materials from damage during shipping, storage, handling and installation. Delivery equipment/materials to the site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

C. The Contractor shall provide for enclosed storage, when equipment/materials are stored on-site and prior to building "dry-in", to prevent any damage resulting from inclement weather or construction traffic. Specialties shall not be stored outdoors.

D. Equipment/materials, stored or installed, found to be damaged shall be replaced with new by the Contractor, to the satisfaction of the Owner and at no additional expense. Do not store equipment with PVC material with exposure to direct sunlight.

E. Deliver fuel gas and medical gas pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

1.14 PERFORMANCE REQUIREMENTS

A. Seismic Performance: All piping and support and installation shall withstand effects of earthquake motions determined according to ASCE 7.

1.15 CORROSIVE ENVIRONMENTS AND SERVICES

A. Corrosive Environments and Corrosive Services shall utilize piping and supports that will not corrode or oxidize due to the environment in which they are located nor due to the fluid contained within the piping. Unless otherwise noted in this spec, corrosive environments and corrosive services shall be defined as the following:

1. Animal Life Support Systems services and piping
2. In areas designated as "water treatment" or "wet", including but not limited to: areas over and within 15'-0" of open water tanks, pools or basins; splash zones;

submerged conditions; ozone rooms; chemical rooms; salt water environments; and other water treatment zones
3. Pool and fountain piping and equipment rooms.
4. Outdoors and within any open air structures within 1 mile of the coast.
5. Within water softener rooms and/or within 15' of water softeners when sharing space/room with other equipment.

B. All piping services in corrosive environments utilizing flanged connections shall be provided with 316 stainless steel hardware including bolts, nuts and washers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection. This is applicable for all Division 22 sections.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

2.3 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D 2235.
2. CPVC Piping: ASTM F 493.
3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4. PVC to ABS Piping Transition: ASTM D 3138.

2.4 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

1. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
2. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.

B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

F. Plain End Pressure Piping to join plastic and stainless steel piping: Utilize double lip seal with bolt tightening pattern. Product shall be equal to Norma FGR Series.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Pipe sizes 2 and smaller, factory-fabricated, union assembly, for 300-psig minimum working pressure at 180 deg F.

D. Dielectric Flanges: Pipe sizes 2-1/2" and larger, factory-fabricated, companion-flange assembly, for 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.6 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.7 FLASHING MATERIALS

A. All piping, conduits and equipment supports through roofs shall be flashed. Flashing materials and methods shall be in accordance to the roof manufacturer's and Division 07 requirements.

2.8 CEILING ACCESS AND ACCESS PANELS

A. Access panels are generally not shown on the drawings, but they are required to be provided by Contractor.

B. Furnish access panels for installation under other Sections valves or other items installed under this Division require access and are concealed in floor, wall, furred space or above ceiling. Access panels shall be by Milcor, Knapp, Nystorm or Inland Steel; coordinate

selection with other Sections supplying similar access panels. Color of panel shall be selected by the Architect.

C. Access panels shall have same fire rating classification as surface penetrated. Rated access panels must have U.L. Label.

D. Final locations of access panels shall be approved by the architect and/or owner prior to installation.

E. All equipment or valves shall be located within two feet above the access panel.

2.9 SLEEVES

A. Below Ground applications:

1. For piping passing from dirt outside of the building footprint through a foundation/basement wall and into the building, a sleeve with an integral water stop shall be utilized. The sleeve can be either HDPE or galvanized steel as manufactured by GPT or approved equal. The sleeve shall be cast into the pour of the structure.
2. When piping is passing from dirt outside of the building footprint to dirt under the building through a structural element, the water-stop on the sleeve is not required. In this application, the sleeve can be either cast iron or PVC piping.
3. Between the carrier piping and the sleeve, a mechanical seal, equal to that manufactured by GPT Link Seal, shall be utilized. Select the number of interlocking rubber links required to make installation watertight.

B. Above ground piping passing through concrete floors:

1. Cast in place sleeves: Piping passing through a floor shall be provided with a sleeve with an integral fire and water-stopping in one device equal to Holdrite Hydroflame. The sleeve shall be cast into the pour of the structure.

   a. At the contractor's option, the sleeve can be either HDPE or galvanized steel with integral water stop as manufactured by GPT or approved equal. The sleeve shall be cast into the pour of the structure. This method requires separate firestopping by the contractor.

2. Sleeves for core-drilled locations: The annular space between the piping and the core shall be provided with mechanical seals equal to that manufactured by GPT Link Seal. Select the number of interlocking rubber links required to make installation watertight.
3. Note: Sleeves are only required for elevated floors. Slab on grade do not require sleeves when a water proofing membrane is not utilized.

C. Above ground piping passing through concrete walls:

1. All piping passing through a concrete wall shall be sleeved with either steel or cast iron piping.

PART 3 - EXECUTION

3.1 PRE-BID SITE VISIT

A. Before submitting bid, visit and carefully examine site to identify existing conditions and difficulties that will affect work of this division. No extra payment will be allowed for additional work caused by unfamiliarity with site conditions that are visible or readily construed by an experienced observer.

B. Contractor shall visit job site to familiarize himself with the specific location of the new equipment installations in existing areas, to ensure there is adequate access for the installation of equipment. All entries, pathways, corridors, stairwells, etc., that may be used to install equipment shall be investigated. All existing conditions and potential obstructions that may impede access and installation shall be addressed prior to equipment purchasing/ordering.

C. The documentation of existing conditions was derived from As-Built documents and are in part unverified. Actual existing conditions shall be verified prior to commencement of work.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

B. Install all piping, systems, equipment, etc. per local code and per the local authority having jurisdiction's (AHJ) requirements. Should any part or component of the drawings or specifications conflict with the local code requirements, the local code requirements shall prevail. The contractor shall inform the design team immediately of any code conflicts.

C. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

D. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise. Exposed surface mounted piping subject to potential damage shall be metallic.

F. To maintain maximum headroom, all piping, duct, conduit, and associated components shall be installed as tight as possible to underside of deck/structure to provide for ease of disconnecting the equipment with minimum interference to other installations.

G. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

H. Install piping to permit valve servicing. No valving shall be located more than 24" above the access panel or removable ceiling panels. Provide necessary fittings and pipe drops, bends, etc to ensure all valving is accessible.

I. Install piping at indicated slopes.

J. Install piping free of sags and bends.

K. Install fittings for changes in direction and branch connections.

L. Install piping to allow application of insulation.

M. Select system components with pressure rating equal to or greater than system operating pressure.

N. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe, conduit and wiring penetrations. Seal penetrations with fire- and smoke-stop materials. Refer to Division 07 for firestopping and fill materials.

O. Waterproof Penetrations: Maintain integrity of waterproof roof, wall and floor penetrations for pipe, conduit and equipment support penetrations. Seal penetrations with waterproof materials with clamps, sleeves, flashings, pipe boots and/or pipe curb assemblies as detailed or specified. Refer to Division 07 for waterproofing methods and materials when not specified in this section.

P. Verify final equipment locations for roughing-in.

Q. Perform work and provide material and equipment as shown on Drawings and/or as specified and/or indicated in this Section of the Specifications. Completely coordinate work with work of other trades and provide a complete and fully functional installation.

R. All exposed piping, fittings, valving, and devices in all food service locations shall be provided with a chrome finish. As an alternate all copper pipe and tube is allowed to be provided with chrome paint in lieu of chrome plating. Exposed copper indirect drain piping does not require painting or plating.

S. All exposed traps, tailpieces, supply and waste piping/tubing and fittings, stops, and the like serving all plumbing fixtures food service locations shall be provided with a chrome finish. As an alternate all copper pipe and tube is allowed to be provided with chrome paint in lieu of chrome plating.

T. Provide plugs or caps for all opening during the construction phase. The temporary plug shall be plastic cap or equivalent. Duct tape is unacceptable for use as a plug, support or to separate ferrous from non-ferrous materials for the construction phase.

U. All materials (e.g. firestopping, insulation mastic, cutting oils, etc.) that are used not only as part of the plumbing system with the CPVC piping, but all products from any other trade that may come in contact with the CPVC piping, shall be listed as approved on the Lubrizol CPVC compatibility charts and by the piping manufacturer. Contractor shall ensure no low voltage cabling is in contact with any CPVC piping.

V. All metal framing members with either factory stamp openings or field punch shall have a plastic sleeve or grommet in place prior to installing any plastic tubing.

W. In concealed locations where piping, other than cast-iron or galvanized steel, is installed through holes or notches in studs, joists, rafters, or similar members less than 1.5” (38mm) from the nearest edge, the piping shall be protected by strike plates (caddy nail plates model #304B2). This is to help protect piping from drywall screws. Piping is to run in the center of stud cavity wherever possible.

X. Install sleeves for piping passing structural elements as indicated above.

Y. Per NFPA 90A, no combustible piping serving water, waste, vent or storm shall be located within any HVAC shaft. Additionally, no gas piping of any type shall share a shaft with ductwork.

Z. Provide a field constructed/fabricated emergency drain pan under all piping located above an electrical room, tele/data room, IT room, transformer room, or any similar room having electrical or low-voltage equipment, gear, panels, and controls to minimize the chance of dripping onto the device. Emergency drain pan shall be designed to have a pipe connection routed to discharge 3" above the floor adjacent to the door entering into the space.

AA. All metallic piping/components in direct contact with either dirt or concrete shall be provided with a 35 mil thick flexible wrap or sleeve equal to Tapecoat CT. Primer to be Tapecoat CT Coldprime or approved equal.

1. The exceptions include all stainless steel piping as well as cast iron when installed in non-corrosive soils.

BB. Coordinate with the electrical contractor to ensure all metallic piping is grounded per the NEC requirements.

CC. Horizontal piping is not to be installed/embedded within a concrete slab unless specifically noted as such.

3.3 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install all equipment per the manufacturer's recommendations.

B. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components, unless otherwise indicated.

D. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

E. Install equipment to allow right of way for piping installed at required slope.

F. Any equipment that may require passwords for access of the controls, shall be provided at no cost to the owner for the life of the system.

3.5 PAINTING

A. Painting of Plumbing systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

C. All plastic piping exposed to direct sunlight shall be painted with 2 coats of water based latex paint.

3.6 CONCRETE BASES

A. Provide raised concrete pads for all floor mounted equipment.

B. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes (if applicable) at Project. Where specific requirements are not specified in Division 3 or detailed on the Drawings, comply with the following at a minimum:

1. Construct concrete bases 4 inches high unless otherwise indicated; and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated.
2. Edges of concrete bases shall have a minimum 1-1/2 inch chamfer.
3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
4. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
5. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
6. Cast anchor-bolt insert into bases. Install anchor bolts to elevations required for proper attachment to supported equipment.
7. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
8. Use 3000-psi, 28-day compressive-strength concrete with wire-mesh reinforcement.

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.

C. Field Welding: Comply with AWS D1.1.

D. Fireproofing:

1. Clips, hangers, clamps, supports and other attachments to surfaces to be fireproofed shall be installed, insofar as possible, prior to start of spray fiber work.
2. Piping and other items which would interfere with proper application of fireproofing shall be installed after completion of spray fiber work.
3. Patching and repairing of fireproofing due to cutting or damaging to fireproofing during course of work specified under this Section shall be performed by installer of fireproofing and paid for by trade responsible for damage and shall not constitute grounds for extra cost to Owner.

3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.9 GROUTING

A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

3.10 WELDING

A. Weld only by approved acetylene or electric welding processes and welders shall hold certificate from approved insurance company.

B. Conduct test to demonstrate suitability of procedures to be used in making welds, which conform to specified requirements.

C. Specification for welding procedure shall meet requirements of Welding Qualifications, Section IX, ASME Boiler and Pressure Vessel Code and ANSI B31.1.

D. Align components. No strain shall be placed on weld during welding. No part of pipe shall be offset more than 20% of thickness. Set flanges and branches properly.

E. Welder and Brazing Qualification:

1. Test welders to demonstrate ability to make acceptable welds. Tests conducted for qualification of welder for work under one Division or Section shall not necessarily qualify welder for work under another Division or Section.
2. Tests shall be as prescribed for welder qualification in Section IX of the ASME code.
3. Records of such tests shall be as follows: Each welder shall be assigned an identifying number, letter or symbol. Identifying mark shall be stamped adjacent to welds made by this welder. Identification shall be at top of horizontal piping and at front of vertical piping.
4. Maintain record of welders employed, showing dates and results of tests and identifying mark assigned to each welder. Certify records and make them accessible

to Owner's project representative and/or project manager. Before completion of project, one copy of records shall be turned over to Owner.

5. No qualification shall be older than three years when welder commences work on this project. If welder has not welded in required welding process for a period of six months, he shall be re-certified.

F. Welding Tests

1. As designated by Architect, remove welds for destructive testing or for testing by non-destructive means. Tests shall be as determined by Architect.
2. If, in Architect's opinion, welds so tested do not meet requirements of Sections VIII and IX of ASME, then the Contractor shall pay for the costs of the tests. Remove welds welded by that welder, at no cost to the Owner. Rewelding shall be performed by qualified welder other than welder whose welds did not pass test. Welders whose welds were defective shall not be employed on site for remainder of project.
3. Welding of stanchions, brackets, anchors and other welding not performed on pipe joints shall be in accordance with requirements of AWS specifications and requirements.

G. Medical Gas Brazing Certification: Submit a copy of Brazing Qualification as required by NFPA 99 ANSI/ASSE Standard 6010, Professional Qualification Standards for Medical Gas and Vacuum System Installers.

3.11 MISCELLANEOUS TESTING AND BALANCING

A. Tests for piping systems and equipment shall be performed as specified in their respective specification sections.

B. No part of any underground work shall be covered until after it is inspected, tested, approved, and photographed.

C. Provide all equipment required for testing, including fittings for additional openings as required.

D. Notify the Architect and any Inspectors required to observe the test, at least 48 hours prior to when the test is ready to be performed.

E. The General Contractor is responsible for certifying in writing, the results of all testing of systems and equipment in this contract. These written results will be required at project close-out.

F. Include description and what portion of the system has been tested. Record date, time, test medium and pressure used, name and title of the person certifying the test. This person shall sign the certification. Forms and data must be legible.

G. When equipment or systems fail to meet minimum test requirements, replace or repair defective work or materials as necessary, and repeat the inspection and test. Make repairs with new materials. No caulking of holes or screwed joints will be allowed.

H. Maintain complete records at the job site of all testing that has been certified. At completion of the project, include in the instruction manuals clearly legible copies of all test approval records and certification.

I. Balance the entire new water distribution system. Set all balancing valves for proper flow control of all circulating water.

J. All flushing valves, pressure regulating valves, or other regulating devices shall be adjusted for proper balancing and flow to the plumbing fixture and/or equipment.

3.12 EXPANSION PROVISIONS

A. Installation of piping must allow for expansion using offsets, loops, swing joints, expansion joints, etc., as necessary to prevent undue strain. Take-offs from mains to run-outs shall not have less than a three-elbow swings.

B. Mains and risers with loops or offsets shall be securely anchored to structure so as to impart expansion toward loops or offsets. Anchors shall be constructed of heavy forged wrought iron, secured to pipe and to structure. Provide vibration isolation as required.

C. Provide pipe alignment guides as required to guide expanding pipe to move freely from anchor points toward expansion joints, offsets, etc.

D. All wood framed structures shall be provided with expansion joints equal to Fernco Expansion Joints on every third floor starting at the top, on every sanitary, storm, and vent stack. The coupling shall allow for a minimum of 1.5”of pipe expansion/wood shrinkage.

3.13 INSTALLATION ONLY ITEMS

A. Where this contractor is required to install items which he does not purchase, he shall coordinate their delivery and be responsible for their unloading from delivery vehicles and for their safe handling and field storage up to the time of installation. This contractor shall be responsible for:

1. Any necessary field assembly and internal connections, as well as mounting in place of the items, including the purchase and installation of all dunnage supporting members and fastenings necessary to adapt them to architectural and structural conditions.
2. Their connection to building systems including the purchase and installation of all terminating fittings necessary to adapt and connect them to the building systems.

B. This Contractor shall carefully examine such items upon delivery. Claims that any of these items have been received in such condition that their installation will require procedures

beyond the reasonable scope of work of this Contractor will be considered only if presented in writing within one week of their date of delivery. Unless such claims have been submitted, this Contractor shall be fully responsible for the complete reconditioning or replacement of the damaged items.

3.14 CLEANING

A. Cleaning shall be performed prior to system start-up.

B. Piping

1. General:

a. After all piping systems have been pressure tested and approved for tightness, flush and clean piping as specified and as required by codes.
b. Furnish pipe cleaning chemicals, chemical feed equipment, materials and labor necessary to flush and clean piping.
c. Permanently install necessary chemical injection fittings complete with stop valves.
d. Monitor the water temperatures and prevent the heat generated by the pump circulating the water from causing the water temperature to exceed the temperature ratings of the pipe, pumps, and other components of the piping system during the flushing and cleaning process.
e. Contractor to provide a portable temporary pumping apparatus for the purpose of flushing and cleaning. Pump shall be adequate to provide the required velocities necessary for the process.
f. When external surfaces of piping are rusted, clean and restore surfaces to original condition.

2. Flushing:

a. All water side equipment control valves, strainers, etc., shall be bypassed prior to and during the flushing process.
b. Flush all water, steam and condensate systems clear of all dirt and foreign matter with all pumps bypassed. All flushing to be at a circulation rate of 6 f.p.s.
c. Maintain continuous blowdown and make-up, as required during flushing operation.
d. Once flushing is complete and prior to cleaning, all final connections to equipment shall be performed.
e. Water samples taken from the system during flushing shall determine when the system is ready for the cleaning process.

3. Cleaning:

a. Clean all pipeline strainer baskets and return to original condition or replace with new baskets prior to the pipe cleaning process.

b. The cleaning chemicals shall be designed to remove deposition from construction, such as pipe dope, oils, loose mill scale, and other extraneous silt and mud. The products shall inhibit corrosion of the various metals in the system and shall be safe to handle and use with normal chemical safety equipment, i.e., gloves and safety glasses. Effectiveness of the product shall be such that the water need only be at ambient temperatures.

c. During the cleaning procedure, remove strainers, automatic air vents, flow regulators and any other item that would be affected by the clean and flush procedure. All control valves and coils should be set up for wide open, full flow.

d. After initial flushing of a system, use portable pumping apparatus for a continuous 24 hour circulation of a cold water detergent equal to Nalco 2567 cleaner.

e. After circulating for the prescribed time, systems shall then be drained and flushed until the total alkalinity or conductivity of the rinse water is not more than 20% higher than the readings for the make-up water. Refill with clean water, and treat with scale and corrosion inhibitor. Contractor shall furnish the chemicals, supervise the cleaning, test the water after flushing, and shall provide a report that certifies successful cleaning and flushing of the piping.

4. Equipment

a. After completion of project, clean the exterior surface of all equipment, including concrete residue, dirt, paint residue, etc.

b. Clean all equipment and plumbing fixtures, as recommended by manufacturer.

c. Thoroughly disinfect all water heating equipment and the complete new domestic water piping system according to Department of Health requirements.

d. All dirt, plaster dust and other foreign matter shall be blown and/or cleaned from coils, terminal devices, diffusers, registers, and grilles.

e. Thoroughly clean equipment of all stains, paint spots, dirt, and dust. Remove all temporary labels not used for instruction or operation.

3.15 COMMISSIONING

A. The Commissioning Authority will be Owner furnished and under direct contract with the Owner. That is, the General Contractor and this subcontractor's bid price shall not include the services of the Commissioning Authority but shall include costs for coordination testing, Contractor commissioning, etc.

3.16 CONTAINMENT ROOM SEALING REQUIREMENTS

A. General

1. Work that penetrates or is mounted on ceilings, walls, floors or other surfaces throughout containment rooms shall be sealed as outlined below in addition to sealing specified elsewhere in the Specifications.
2. Completely seal the perimeter joints around all insulated and uninsulated penetrations and surface-mounted items.

B. Products

1. Acceptable sealant materials shall be products that conform to ASTM C920 "Specifications for Elastomeric Joint Sealants". Sealant shall adhere to substrates, and maintain seal under normal expected movements of substrates.
2. Sealant specified herein shall be 732-RTV silicone rubber as manufactured by Dow Chemical Co. or equivalent by GE. Color shall be clear.

C. Installation

1. Preparation, priming (as applicable), application, curing and protection of the sealant shall be in conformance with the recommendations of the sealant manufacturer.
2. If necessary, fill voids with backer rods as recommended by the sealant manufacturer.
3. Mask edges of exposed joints if required to make neat joints and prevent excessive misplacement of sealant onto exposed surfaces adjacent to joints.
4. Perform sealant work after adjacent painting work is complete and dry.
5. Sealant shall be free of voids, be applied in one continuous bead and be tooled concave and smooth.

END OF SECTION

SECTION 22 05 10 – PLUMBING DEMOLITION AND ALTERATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:

1. Disconnection of plumbing equipment in selected portions of building or structure.

2. Demolition and removal of selected plumbing components.

3. Salvage of existing items to be reused or recycled.

B. Related Requirements:

1. Division 01 Section "Cutting and Patching."

2. Division 02 Section "Selective Structure Demolition" for sequencing and scheduling procedures and requirements for demolition activities.

1.3 JOB CONDITIONS

A. Perform all demolition as needed to accomplish new work.

B. Do not rely solely on plumbing drawings to determine extent of general construction demolition. Refer to architectural demolition plans for the exact extent of general construction demolition required by this contract.

C. This Contractor is responsible for all charges, fees etc. incurred as a result of the plumbing portion of the demolition.

D. Prior to demolition or alteration of structures, the following shall be accomplished:

1. Review available record documents of the existing construction. Owner does not guarantee that existing conditions are same as those indicated in record documents.

2. Coordinate sequencing with Owner and other Contractors.

3. Coordinate means to separate construction zones from non-renovated zones to prevent the spread of dust, fumes and debris.

4. Except as noted otherwise, remove from the premises, all materials and equipment removed in the demolition work.

5. Equipment noted to be removed and turned over to the Owner, shall be delivered to the Owner at a place and time he so designates.

6. Where the materials are to be turned over to the Owner or reused and installed by the Contractor, it shall be the Contractor's responsibility to maintain the condition of the materials and equipment equal to that existing before work began. Damaged materials or equipment shall be repaired or replaced at no additional cost to the Owner.

7. Survey and record condition of existing facilities to remain in place that may be affected by demolition operations. After demolition operations are completed, survey conditions again and restore existing facilities to their pre-demolition condition, at no additional cost to Owner.

8. Salvage equipment scheduled for reuse in new work or scheduled to be delivered to Owner's storage facility.

PART 2 - PRODUCTS
Not used.

PART 3 - EXECUTION

3.1 DEMOLITION

A. Existing plumbing equipment in conflict with new construction shall be removed and/or relocated as indicated on the drawings, as directed or needed. This Contractor shall remove all plumbing equipment released from service as a result of construction, and no equipment removed shall be reused, except as specifically directed on the drawings or elsewhere herein. All plumbing components shall be stored on site for Owner assessment. Any components not retained by the Owner shall be removed by the contractor. Properly dispose or remove from site any items not retained by Owner.

B. Any existing services or equipment not shown on the drawings and which are logically expected to be continued in service and which may be interrupted or disturbed during construction, shall be reconnected in an approved manner. Provide temporary pipes, controls, etc., as needed to prevent interruption of service to occupied areas caused by demolition operations. In addition, any piping, fixtures, or equipment which may require relocation or rerouting as a result of construction, shall be considered a part of the work of this section and shall be done by this Contractor with no additional compensation,

provided that the referenced relocation is discernable from the pre-bid review of the site, and associated documents.

C. This Contractor shall remove all fixtures, piping, hangers, and existing equipment, being discontinued or removed due to construction. Abandoned or removed services shall be disconnected and capped at the perimeter of the project or as required elsewhere in the documents. Piping shall be capped with the same or compatible piping material. Piping being abandoned in place shall be drained.

D. The existing building is to remain in operation during construction. This Contractor shall coordinate all work that will interfere with the present operation of the facility with the Owner and Construction Manager.

E. All existing equipment that is to remain shall be cleaned inside and out. Clean all pipeline strainer baskets and return to original condition or replace with new baskets. All dirt, plaster dust and other foreign matter shall be blown and/or cleaned from all equipment. Touch up paint on equipment in exposed areas.

F. Equipment being removed shall be disconnected and have the services capped.

G. Equipment being removed and reinstalled shall be disconnected, have the services capped, remove, clean and store the equipment until appropriate the reinstalled, connected and made operational.

H. Equipment being removed and salvaged shall be disconnected and have the services capped. The equipment shall then be turned over to the owner.

I. Plumbing fixtures indicated to remain shall be wiped clean on all surfaces to remove all dirt, plaster dust or other foreign materials.

J. All coring that is required for plumbing work shall be done by this Contractor.

K. All cutting and patching required for plumbing work shall be by this Contractor.

L. This Contractor shall provide required additional support for existing piping in remodeled area that is not being removed and is not properly supported.

M. When existing piping or related equipment in remodeled areas prevents the installation of other work, remove and reinstall existing materials, making necessary modifications and transitions to coordinate with other trades.

N. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 CLEANING AND REPAIR

A. Clean existing materials and equipment which remain or are to be reused. Report damage or defects to Architect

3.3 TESTING

A. Existing equipment shall be tested before demolition begins to determine existing operating conditions and capacities. Upon completion of all new work, the existing equipment shall be tested to ensure correct operation.

END OF SECTION

SECTION 22 05 19 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Bimetallic-actuated thermometers.
2. Liquid-in-glass thermometers.
3. Thermowells.
4. Dial-type pressure gages.
5. Gage attachments.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

A. Available Manufacturers:

1. Trerice, H. O. Co.
2. Weiss Instruments, Inc.
3. Winters Instruments

B. Thermometers shall be 5 inch, round bi-metal type, stainless steel case, readable scale and gradations from 30 degrees F. to 240 degrees F., external calibrator adjustment, back or bottom connection as appropriate. Provide brass extension neck sockets of appropriate length. Thermometers shall be equal to Trerice Series #B85200.

2.2 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Available Manufacturers:

a. Trerice, H. O. Co.
b. Weiss Instruments, Inc.
c. Winters Instruments

2. Thermometers shall be 9 inch, die cast aluminum case, double strength glass window, adjustable angle stem, lens, front reading mercury tube, readable scale with gradations from 30 degrees F. to 240 degrees F.. Provide brass extension neck sockets of appropriate length. Thermometers shall be equal to Trerice Series #BX91400.

2.3 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Bore Diameter and Insertion length: Required to match thermometer bulb or stem.
4. Lagging Extension: Include on thermowells for insulated piping and tubing.
5. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

2.4 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Available Manufacturers:

a. Trerice, H. O. Co.
b. Weiss Instruments, Inc.
c. Winters Instruments

2. Pressure gauge shall be 4-1/2 inch die cast aluminum case, double strength glass window, readable dial scale with gradations form 0 psi to 200 psi phosphor bronze bourdon tube, stainless steel movement. Provide shutoff valve with pressure gauge. Shall be equal to Trerice Series #500X.
3. Pressure gauge shall be 3-1/2 inch die cast aluminum case, double strength glass window, readable dial scale with gradations from 0 psi to 200 psi, phosphor bronze bourdon tube, brass socket. Provide shutoff valve with pressure gauge. Shall be equal to Trerice Series #600.

4. Pressure gauge shall be 3-1/2 inch stainless steel case, glass window, readable dial scale with gradations from 0 psi to 200 psi, phosphor bronze bourdon tube, brass socket. Provide shutoff valve with pressure gauge. Shall be equal to Trerice Series #690.

2.5 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass or stainless-steel needle with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.6 PETES PLUGS

A. Brass or stainless valve body with a pressure rating higher than the system pressure consisting of self-closing valves with a restrained gasketed cap on the top. Utilize valve material compatible with hot and cold domestic water.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending to center of pipe and in vertical position in pipe tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install pressure gages in piping tees with gage located on pipe at the most readable position.

G. Install valve and snubber in piping for each pressure gage for fluids.

H. Install thermometers in the following locations:

1. Inlet and outlet of each water heater.
2. Inlets and outlets of each domestic water heat exchanger.
3. Inlet and outlet of each domestic hot-water storage tank.

4. Inlet and outlet of each domestic water chiller.

I. Install pressure gages in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.
3. Suction and discharge of each domestic water pump.

J. Install petes plugs in the following locations:

1. Suction and discharge of each domestic water pump.
2. Inlet and outlet of each pressure-reducing valve.
3. Inlet and outlet of each water heater.
4. Inlet and outlet of each domestic hot-water storage tank.

K. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

L. Adjust faces of meters and gages to proper angle for best visibility.

M. Thermometers and pressure gauges shall be any of the respective items listed in the above sections.

END OF SECTION

SECTION 22 05 23 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Ball valves.
2. Butterfly valves.
3. Check valves.
4. Gate valves.

B. Related Sections:

1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve indicated.

1.4 PERFORMANCE REQUIREMENTS

A. Products shall be suitable for the indicated service including piping system fluids, materials, pressures, and temperatures.

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

2. ASME B31.1 for power piping valves.

3. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.

1. All plumbing components, including but not limited to piping, valves, backflow preventers, fixtures, etc that are connected to the domestic water system which convey water to be used for human consumption shall meet the NSF-372, 'Lead-Free' requirements. Items not intended to dispense water for human consumption such as flush valves, tub fills, shower valves, or piping accessories connected to non-potable water systems, are not required to meet the 'Lead Free' requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Use the following precautions during storage:

1. Maintain valve end protection.

2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

B. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 8 and larger.

2. Handwheel: For valves other than quarter-turn types.

3. Handlever: For quarter-turn valves NPS 6 and smaller.

4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug-valve head.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.

2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

3. Butterfly Valves: With extended neck.

F. Valve Bypass and Drain Connections: MSS SP-45.

G. Valves with push type connections are prohibited. Valves with press connections are only allowed in systems where press connect fittings are allowed. Valves with PEX connections are only allowed in systems fully utilizing PEX piping. In grooved installations, grooved-ended valves shall be the same manufacturer as the grooved system.

2.2 BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim or Heat Treated Forged Brass Ball valve with Heat Treated Forged Brass Trim:

1. Manufacturers:

a. Conbraco Industries, Inc.; Apollo Valves.

b. Jomar Valve

c. Hammond Valve.

d. Milwaukee Valve Company.

e. NIBCO INC.

2. Description:

a. Standard: MSS SP-110 or MSS SP-145.

b. SWP Rating: 150 psig.

c. CWP Rating: 600 psig.

d. Body Design: Two piece.

e. Body Material: Bronze or Heat Treated Forged Brass.

f. Seats: PTFE or TFE.

g. Stem: Bronze or Heat Treated Forged Brass.

h. Ball: Chrome-plated brass.

i. Port: Full.

j. If a heat treated brass alloy valve is utilized, it must be CW511L tested in accordance with ISO 6509.

2.3 BUTTERFLY VALVES

A. 300 PSI, Grooved, Brass Butterfly Valves with Aluminum Bronze Disc

1. Manufacturers: Victaulic #608N

2. Description: 2-1/2" - 4", 300 psi maximum pressure rating, with copper tubing sized grooved ends. Cast brass body to UNS C87850. (Alloy code shall be cast or stamped into the valve body.) Aluminum bronze disc to UNS C95500, with pressure responsive fluoroelastomer blend seat optimized for improved resistance to chlorine, chloramine, and other typical potable water disinfectants. UL Classified in accordance with ANSI/NSF 61 for cold and hot potable water service and ANSI/NSF 372. Stem shall be offset from the disc centerline to provide complete 360-degree circumferential seating. Bubble tight, dead-end or bi-directional service, with memory stop for throttling, metering or balancing service. Valve may be automated with electric, pneumatic, or hydraulic operators. Certified to the low lead requirements of NSF-372.

2.4 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Nonmetallic Disc:

1. Manufacturers:

a. Conbraco Industries, Inc.; Apollo Valves.

b. Jomar Valve

c. Kitz Corporation.

d. Milwaukee Valve Company.

e. NIBCO INC.

2. Description:

a. Standard: MSS SP-80, Type 2.

b. CWP Rating: 200 psig.

c. Body Design: Vertical flow.

d. Body Material: ASTM B584, bronze.

e. Disc: NBR, PTFE, or TFE.

2.5 BRONZE SWING CHECK VALVES

A. Bronze Swing Check Valves:

1. Manufacturers:

a. Conbraco Industries, Inc.; Apollo Valves

b. Crane Co.; Crane Valve Group;

c. Hammond Valve.

d. Jomar Valve

e. Milwaukee Valve Company.

f. NIBCO INC.

2. Description:

a. Standard: MSS SP-80 Type 3 or Type 4, or MSS SP-139.

b. CWP Rating: 200 psig.

c. Body Design: Horizontal flow.

d. Body Material: ASTM B584, bronze.

e. Disc Seat: Bronze or PTFE.

2.6 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:

1. Manufacturers:

a. Crane Co.; Crane Valve Group

b. Jomar Valve

c. Milwaukee Valve Company.

d. NIBCO INC.

e. Powell Valves.

f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-71, Type I.

b. CWP Rating: 200 psig.

c. Body Design: Clear or full waterway.

d. Body Material: ASTM A 126, gray iron with bolted bonnet.

e. Trim: Bronze.

f. Gasket: Asbestos free.

2.7 BRONZE GATE VALVES

A. Class 125 Bronze Gate Valves:

1. Manufacturers:

a. Crane Co.; Crane Valve Group;

b. Hammond Valve.

c. Milwaukee Valve Company.

d. NIBCO INC.

e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80 or MSS SP-139.

b. CWP Rating: 200 psig.

c. Body Material: ASTM B584, bronze with integral seat and screw-in bonnet.

d. Stem: Bronze.

e. Disc: Solid wedge; bronze.

f. Packing: Asbestos free.

g. Handwheel: Malleable iron or aluminum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Examine grooved ends for form and cleanliness. Ends shall be clean and free from indentations and projections in the area from valve end to (and including) the groove.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions, grooved-joint couplings, or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary. Where piping is more than 24" above an accessible ceiling, provide a drop in the pipe to bring the valve to within 24" of the ceiling.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops.

F. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.

2. Center-Guided Check Valves: In horizontal or vertical position, between flanges.

3. Lift Check Valves: With stem upright and plumb.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball, butterfly valves.

2. Butterfly Valve Dead-End Service: Single-flange (lug) or grooved-end type.

3. Throttling Service: Ball or butterfly valves.

B. Valve pressure ratings shall be no less than the system pressure for any application. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Ball Valves: Two piece, full port, with brass trim.

2. Bronze Swing Check Valves: bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1.

2. Brass Butterfly Valves: 300 PSI, aluminum-bronze disc, grooved ends.

3. Iron Swing Check Valves with nonmetallic-to-metal seats.

END OF SECTION

SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following hangers and supports for plumbing system piping and equipment:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Pipe positioning systems.
8. Equipment supports.

B. Related Sections include the following:

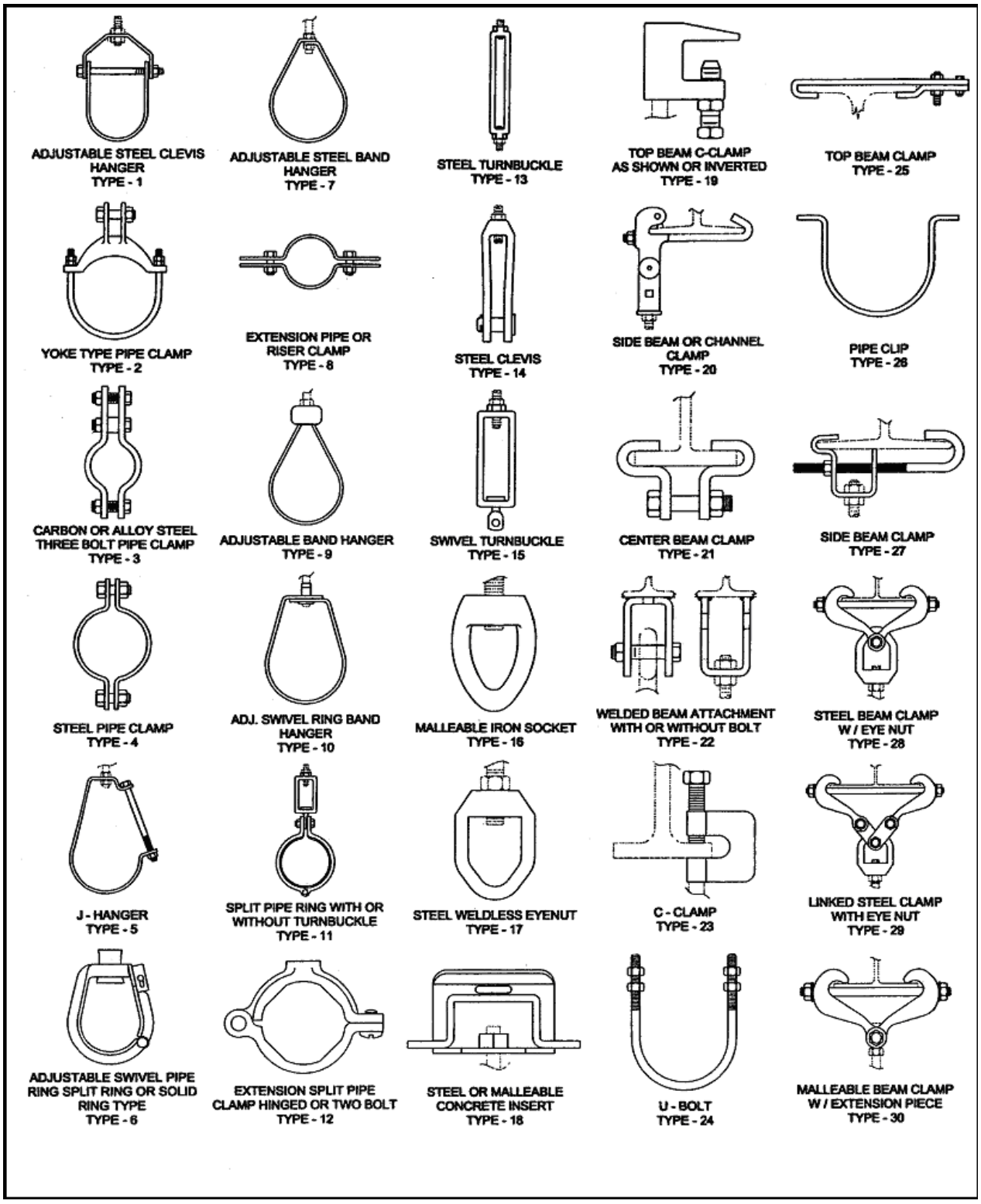
1. Division 22 Section "Seismic Restraint for Plumbing Piping and Equipment" for requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.

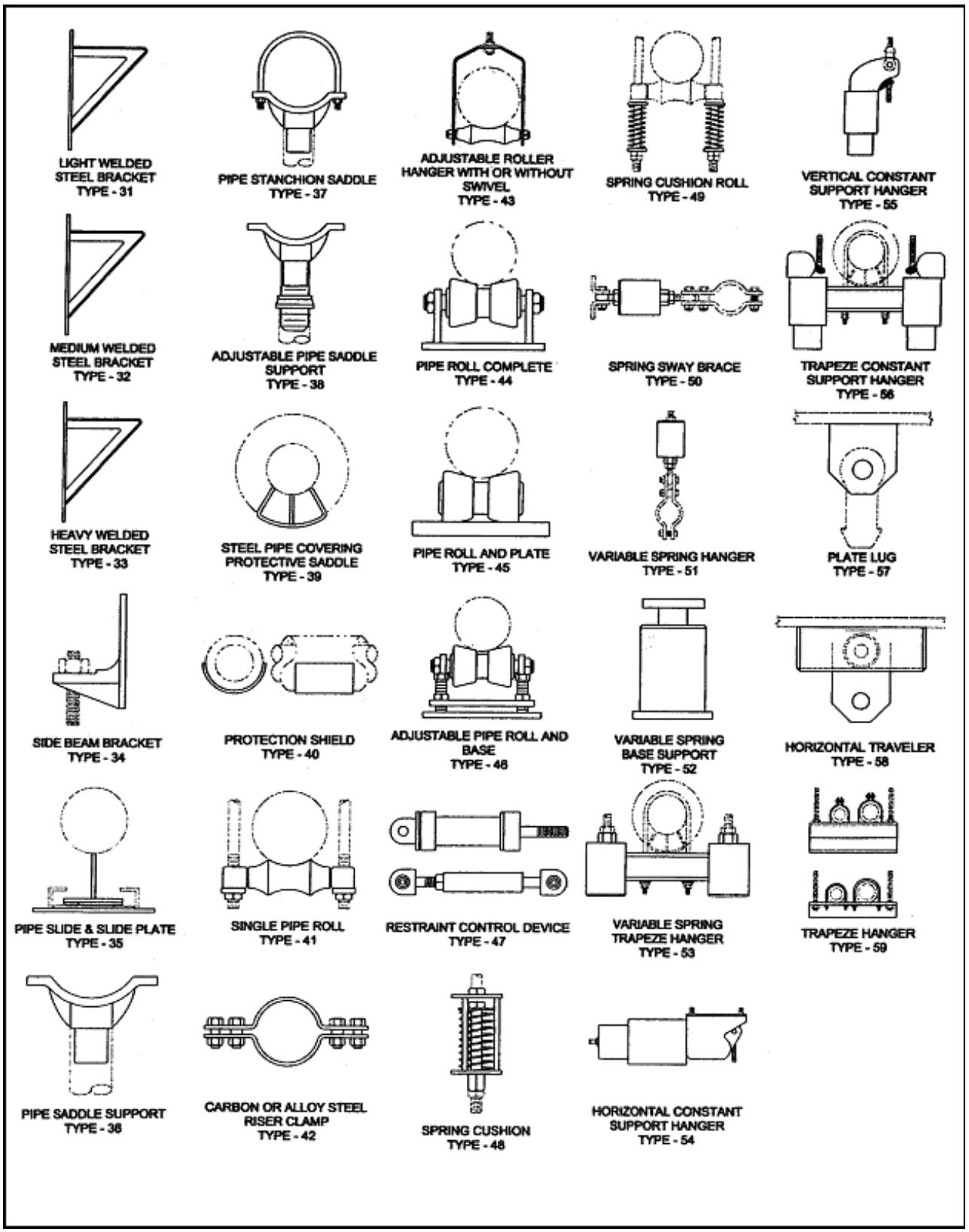
B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports", refer to the following figures when the “Type” hanger or support is indicated in Part 2 and 3 of this specification.

C.


ADJUSTABLE STEEL CLEVIS HANGER TYPE - 1
ADJUSTABLE STEEL BAND HANGER TYPE - 7
STEEL TURNBUCKLE TYPE - 13
TOP BEAM C-CLAMP AS SHOWN OR INVERTED TYPE - 19
TOP BEAM CLAMP TYPE - 25
YOKE TYPE PIPE CLAMP TYPE - 2
EXTENSION PIPE OR RISER CLAMP TYPE - 8
STEEL CLEVIS TYPE - 14
SIDE BEAM OR CHANNEL CLAMP TYPE - 20
PIPE CLIP TYPE - 26
CARBON OR ALLOY STEEL THREE BOLT PIPE CLAMP TYPE - 3
ADJUSTABLE BAND HANGER TYPE - 9
SWIVEL TURNBUCKLE TYPE - 15
CENTER BEAM CLAMP TYPE - 21
SIDE BEAM CLAMP TYPE - 27
STEEL PIPE CLAMP TYPE - 4
ADJ. SWIVEL RING BAND HANGER TYPE - 10
MALLEABLE IRON SOCKET TYPE - 16
WELDED BEAM ATTACHMENT WITH OR WITHOUT BOLT TYPE - 22
STEEL BEAM CLAMP W / EYE NUT TYPE - 28
J - HANGER TYPE - 5
SPLIT PIPE RING WITH OR WITHOUT TURNBUCKLE TYPE - 11
STEEL WELDLESS EYENUT TYPE - 17
C - CLAMP TYPE - 23
LINKED STEEL CLAMP WITH EYE NUT TYPE - 29
ADJUSTABLE SWIVEL PIPE RING SPLIT RING OR SOLID RING TYPE TYPE - 6
EXTENSION SPLIT PIPE CLAMP HINGED OR TWO BOLT TYPE - 12
STEEL OR MALLEABLE CONCRETE INSERT TYPE - 18
U - BOLT TYPE - 24
MALLEABLE BEAM CLAMP W / EXTENSION PIECE TYPE - 30

D.

E.


LIGHT WELDED STEEL BRACKET TYPE - 31
PIPE STANCHION SADDLE TYPE - 37
ADJUSTABLE ROLLER HANGER WITH OR WITHOUT SWIVEL TYPE - 43
SPRING CUSHION ROLL TYPE - 49
VERTICAL CONSTANT SUPPORT HANGER TYPE - 55
MEDIUM WELDED STEEL BRACKET TYPE - 32
ADJUSTABLE PIPE SADDLE SUPPORT TYPE - 38
PIPE ROLL COMPLETE TYPE - 44
SPRING SWAY BRACE TYPE - 50
TRAPEZE CONSTANT SUPPORT HANGER TYPE - 56
HEAVY WELDED STEEL BRACKET TYPE - 33
STEEL PIPE COVERING PROTECTIVE SADDLE TYPE - 39
PIPE ROLL AND PLATE TYPE - 45
VARIABLE SPRING HANGER TYPE - 51
PLATE LUG TYPE - 57
SIDE BEAM BRACKET TYPE - 34
PROTECTION SHIELD TYPE - 40
ADJUSTABLE PIPE ROLL AND BASE TYPE - 46
VARIABLE SPRING BASE SUPPORT TYPE - 52
HORIZONTAL TRAVELER TYPE - 58
PIPE SLIDE & SLIDE PLATE TYPE - 35
SINGLE PIPE ROLL TYPE - 41
RESTRAINT CONTROL DEVICE TYPE - 47
VARIABLE SPRING TRAPEZE HANGER TYPE - 53
TRAPEZE HANGER TYPE - 59
PIPE SADDLE SUPPORT TYPE - 36
CARBON OR ALLOY STEEL RISER CLAMP TYPE - 42
SPRING CUSHION TYPE - 48
HORIZONTAL CONSTANT SUPPORT HANGER TYPE - 54

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers, pipe hangers utilizing structural steel members, and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Refer to section 22 05 00 'Common Work Results for Plumbing' for any corrosive items or locations this project may contain.

C. General: Hangers and supports for piping and equipment shall withstand the effects of loads and stresses within limits and under conditions indicated according to ASCE 7. Design piping and equipment supports, including pipe stands, to support combined loads of supported systems, equipment and system contents.

D. Delegated Design for Wind Loads: Exterior equipment and associated mounting assemblies, exterior piping, and the attachment to structure shall meet the wind structural loading requirements of the local Building Codes and Authorities Having Jurisdiction.

1. Wind Design Pressures: As determined from wind speed, building category, wind exposure indicated on the structural drawings for specific equipment location calculated per the structural wind loading requirements of the Building Code.

2. Structural Attachment Forces: As determined from wind design pressures using actual equipment dimensions calculated per the structural wind loading requirements of the Building Code.

E. Seismic: Equipment and associated mounting assemblies shall withstand the effects of seismic forces in accordance with project Seismic specifications.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for shop and field fabricated pipe and equipment support systems.

1.6 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

1.7 DESIGN CRITERIA

A. When this specification includes both insulation protection shields and thermal pipe shields, the Contractor may use either device, coordinated with insulation specifications.

B. Contractor is responsible for proper placement of supporting devices to accommodate insulation and pitching of pipe as specified in other sections.

C. Provide vibration isolation and/or seismic restraints as specified in other sections.

D. Where piping can be conveniently grouped to allow the use of trapeze type supports, the supporting steel shall be by means of standard structural shapes or continuous insert channels.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.

3. Nonmetallic Coatings: Plastic coating, jacket, or liner.

4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

5. Hanger Rods: Continuous-thread rod, nuts, and washer; all items made of carbon steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.

2. Hanger Rods: Continuous-thread rod, nuts, and washer; all items made of stainless steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

1. The total weight of piping and components upon each trapeze span shall not exceed the manufacturers load rating. Load ratings must include a minimum 2 X safety factor.

2.3 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.

C. Channels: Continuous slotted steel channel with inturned lips.

D. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

E. Hanger Rods: Continuous-thread rod, nuts, and washer; all items made of carbon steel.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psigminimum compressive strength and vapor barrier or water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psigminimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig or ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used. Stainless anchors shall be used in exterior or corrosive interior applications.

2.6 PIPE STAND

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support floor or roof-mounted piping.

1. Floor stands shall be secured to the floor with 316 stainless steel hardware.

B. Pipe Stands Zero Roof Penetration Type:

1. Compact Pipe Stand: One-piece base unit with rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

2. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.

3. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.

a. Base: Plastic, Stainless steel, or rubber.

b. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.

c. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

4. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

5. Note, the above listed pipe stands will not provide a code compliant wind nor seismic support system. The entire system shall be delegated design as noted previously utilizing a combination of supports anchored to the building's structure as well as those that do not penetrate the roofing (floating or non-anchored).

2.7 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.

B. Manufacturers:

1. HOLDRITE Corp.; Hubbard Enterprises.

2.8 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Use zinc coated carbon-steel hangers, supports, and attachments for general service applications.

B. Use hangers and supports with galvanized, metallic coatings for piping and equipment exposed to weather/moisture and that will not have field-applied rust preventative finish.

C. Use 316 stainless-steel pipe hangers and attachments for corrosive environment applications.

D. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Use thermal-hanger shield inserts for insulated piping and tubing.

G. Comply with MSS SP-69 for pipe hanger and support selections and applications that are not specified in piping system Sections.

H. Plastic coated or copper-plated hangers shall be provided for copper piping in direct contact with hangers. Use padded hangers for piping that is subject to scratching.

I. Horizontal-Piping Hangers: Unless otherwise indicated, install the following types:

1. Adjustable, Clevis Hangers (MSS Type 1): For suspension of individual piping

2. Loop Hangers (MSS Type 7) for piping NPS 3 and below are only acceptable when the ceiling space is such that the clevis hangers (MSS Type 1) will not fit in the available space.

J. Horizontal-Piping Supports: Unless otherwise indicated, install the following types when supporting pipe from below either in equipment rooms or at exterior locations:

1. Adjustable, Pipe Stanchion Saddles (MSS Type 38): For support of individual pipes, with adjustable steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.

2. Adjustable, Pipe Saddle Supports (MSS Type 37): For support for individual pipes, NPS 2 to NPS 8, with all thread rod for height adjustment and U-bolt to retain pipe.

3. Pipe rails or Pipe Stands: For support of multiple horizontal piping.

   a. Rail or stand support selected and sized for associated loads suitable for mounting each pipe with (MSS Type 24) standard U-Bolt pipe strap, strut mounted pipe guide or (MSS Type 41 or 44) pipe roller.

   b. Pipe strap (MSS Type 24) for all systems NPS 1 1/2 and smaller.

   c. Pipe strap (MSS Type 24) for ambient and cold systems (119 deg F and below) NPS 2 and above not subject to seismic movement.

   d. Pipe roller (MSS Type 41 or 44) for hot systems (120 deg F and above) NPS 2 and above subject to thermal and seismic movement.

4. Utilize individual adjustable type pipe support for piping which requires a specific slope.

K. Vertical-Piping Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

3. Piping larger than 4", of lengths exceeding 30 feet, shall be additionally supported on base elbows secured to the building structure, with flexible supporting hangers, provided at top of riser to allow for pipe expansion.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

6. C-Clamps (MSS Type 23): For structural shapes.

7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.

    b. Medium (MSS Type 32): 1500 lb.

    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.

2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.

3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

N. Comply with MFMA-102 for all metal framing system selections and applications.

O. Support of pipe, tubing and equipment shall be accomplished by means of engineered products, specific to each application. Makeshift, field devised methods are not allowed.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Metal Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.

2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled framing system.

E. Pipe Stand Installation:

1. Pipe Stands: Assemble stand components and secure to roof, equipment room, or equipment yard concrete slab.

2. Roof Curb or Rail Mounted Type: Assemble stand components and secure to roof curb or rail.

3. Zero Roof Penetration type pipe stands/supports can be utilized where allowed by the local seismic requirements, wind loading requirements, and the AHJ permits.

4. Provide insulation shields, support types and slope in accordance with specified requirements.

F. Secure exterior equipment and mounting assemblies to structure with positive attachments in accordance with project's seismic and/or wind loading requirements.

G. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

H. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, backing plates and other accessories.

I. Comply with mounting and anchoring requirements for seismic installations. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units

J. All vertical risers shall be supported at each floor with riser clamp.

K. Install lateral bracing with pipe hangers and supports to prevent swaying.

L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, strainers, NPS 2-1/2and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

M. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

O. Insulated Piping:

1. Attach clamps and spacers to piping.

a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.

b. NPS 4: 12 inches long and 0.06 inch thick.

c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.

d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.

e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.

6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

7. Hangers shall be installed outside on insulated piping with protection for insulation provided by shields or saddles. Shields or saddles shall be sized to prevent depression of insulation as recommended by insulation manufacturer. However insulated drainage pipe shall have the hanger support on the pipe to insure proper pitch.

P. No-hub pipe and fitting coupling joints that are exposed to thrust pressures greater than those recommended by the pipe and fitting manufacturer shall receive auxiliary support by means of appropriate bracing materials, as referred to in CISPI Designation 310-04, 301-09, 301-12, the CISPI Cast Iron Soil Pipe and Fittings Handbook, and the applicable plumbing code. Auxiliary restraint products used shall be manufactured assemblies with thrust pressure rating adequate for the specific installation and shall be installed onto horizontal joints NPS 4 diameter and larger in size. Field devised methods and materials shall not be used to accomplish this application solution. Restraints shall be equal to that manufactured by Holdrite #117.

Q. Provide support for all p-traps NPS 4and larger in size.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touch Up: Clean field welds, bolted connections and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as

used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 SPACING

A. Refer to individual piping sections for spacing requirements.

B. Where no requirement is specified elsewhere, pipe hangers and supports shall be per MSS SP-90.

C. Space pipe hangers and supports in accordance with following tables, with exceptions as indicated herein.

D. The vertical spacing shall be at each floor level, with spacing not to exceed that shown in the table below. Provide mid story guides on PEX, PVC, PP, and CPVC piping per local code requirements.

Table 1 – Maximum Horizontal Pipe Hanger and Support Spacing

		1		2		3		4		5	6	7	9
NOMINAL PIPE OR TUBE SIZE		STD WT STEEL PIPE				COPPER TUBE				CSST	DUCTILE IRON PIPE	CAST IRON SOIL	PLASTIC PVC
		WATER SERVICE		VAPOR SERVICE		WATER SERVICE		VAPOR SERVICE					
in.	mm	ft.	m	ft.	m	ft.	m	ft.	m				
1/4	(6)					5	1.5	5	1.5	FOLLOW REQUIREMENTS OF THE PIPING MANUFACTURER.	10 FT. (3.0m) MAX SPACING.	WITH COMPRESSION GASKETS AND NO-HUB, SUPPORT AT EVERY OTHER JOINT UNLESS OVER 4 FEET THEN SUPPORT AT EVERY JOINT. SUPPORT ADJACENT TO ECH JOINT. NOT TO EXCEED 18”.	4 FT. (1.22m) MAX SPACING.
3/8	(10)	7	2.1	6	1.8	5	1.5	6	1.8				
1/2	(15)	7	2.1	6	1.8	5	1.5	6	1.8				
3/4	(20)	7	2.1	8	2.4	5	1.5	6	2.1				
1	(25)	7	2.1	8	2.4	6	1.8	6	2.4				
1-1/4	(32)	7	2.1	10	3.0	6	2.1	6	2.7				
1-1/2	(40)	9	2.7	10	3.0	6	2.1	6	3.0				
2	(50)	10	3.0	10	3.0	8	2.4	10	3.4				
2-1/2	(65)	11	3.4	10	3.0	9	2.7	10	4.0				
3	(80)	12	3.7	10	3.0	10	3.0	10	4.3				
3-1/2	(90)	12	3.7	10	3.0	10	3.0	10	4.6				
4	(100)	12	3.7	10	3.0	10	3.0	10	4.9				
5	(125)	12	3.7	10	3.0	10	30	10	4.9				
6	(150)	12	3.7	10	3.0	10	3.0	10	4.9				
8	(200)	12	3.7	10	3.0	10	3.0	10	4.9				
10	(250)	12	3.7	10	3.0	10	3.0	10	4.9				
12	(300)	12	3.7	10	3.0	10	3.0	10	4.9				
14	(350)	12	3.7	10	3.0								
Vertical Spacing		25	7.6	Per Code		10	3.0	Per Code		Per Manufacturer	15’ (4.5m)	15’ (4.5m)	Each floor

		COLUMNS(3) 1, 2, 6, 7		COLUMNS(3) 3, 4, 9, 10, 11, 12, 13	
NOMINAL PIPE OR TUBING SIZE		NOMINAL ROD DIA.		NOMINAL ROD DIA.	
in	mm	in	mm	in	mm
1/4	(6)			3/8	M10
3/8	(10)	3/8	M10	3/8	M10
1/2	(15)	3/8	M10	3/8	M10
3/4	(20)	3/8	M10	3/8	M10
1	(25)	3/8	M10	3/8	M10
1-1/4	(32)	3/8	M10	3/8	M10
1-1/2	(40)	3/8	M10	3/8	M10
2	(50)	3/8	M10	3/8	M10
2-1/2	(65)	1/2	M12	1/2	M12
3	(80)	1/2	M12	1/2	M12
3-1/2	(90)	1/2	M12	1/2	M12
4	(100)	5/8	M16	1/2	M12
5	(125)	5/8	M16	1/2	M12
6	(150)	3/4	M20	5/8	M16
8	(200)	3/4	M20	3/4	M20
10	(250)	7/8	M22	3/4	M20
12	(300)	7/8	M22	3/4	M20
14	(350)	1	M24		
16	(400)	1	M24		
18	(450)	1	M24		
20	(500)	1-1/4	M30		
24	(600)	1-1/4	M30		
30	(750)	1-1/4	M30		

NOTE:

(1) For calculated loads, rod diameters may be sized in accordance with MSS SP-58, Table 3 provided Table 1 and Section 7.3 of MSS SP-58 are satisfied.

(2) Rods may be reduced one size for double rod hangers. Minimum rod diameter shall be 3/8 in. (M10).

(3) Columns noted refer to Table 1, maximum horizontal pipe hanger and support spacing.

END OF SECTION

SECTION 22 05 49 - SEISMIC RESTRAINT FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including general and supplementary conditions and Division 01 specifications, apply to this section.

1.2 SUMMARY

A. Related Requirements:

1. Division 22 Section “Hangers and Supports for Plumbing Piping and Equipment” for commonly used supports and installation requirements.

2. Division 22 Section “Vibration Controls for Plumbing Systems” for restrained vibration isolation devices.

1.3 DEFINITIONS

A. ASCE: American Society of Civil Engineers.

B. CBC: California Building Code.

C. Life Safety \ Emergency Systems:

1. All medical and life support systems.

D. HCAI: California Department of Health Care Access and Information

1.4 PERFORMANCE REQUIREMENTS

A. Equipment and Distribution Components: Select support, attachment, and restraint details complying with requirements of CBC and ASCE 7 for equipment and distribution components from one of the following OSHPD Pre-Approvals:

1. Cooper B-Line (OPA-0114).

2. SMACNA (OPA-0010).

3. Mason Industries (OPA-0349).

4. ISAT (OPA-0485).

B. Use seismic design values shown on structural drawings.

C. Treat components that are part of life safety / emergency systems as having Component Importance Factor = 1.5. Treat other components as having Component Importance Factor = 1.5 if so scheduled on the drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Delegated-Design Submittal: For seismic restraint details governed by performance requirements, include analysis data signed and sealed by a professional engineer responsible for their preparation who is qualified for such work in the place of the project.

1. Design Calculations: Calculate loading due to equipment weight, operation, and seismic forces required to select seismic restraints.

2. Include materials and dimensions and identify hardware, including attachment and anchorage devices, for equipment and for manufactured and field fabricated supports.

3.

4. Seismic Restraint Details:

a. Design Analysis: Support selection and arrangement of seismic restraints.

b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Identify components, Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices, where applicable.

c. Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

B. Coordination Drawings: Show proposed locations of supports and restraints for distribution system components.

1. Show coordination of seismic bracing for plumbing components with other systems and equipment in the vicinity, including other supports and seismic restraints.

2. Include details selected from OSHPD Pre-Approvals, and reference proposed locations to specific details selected.

3. Reference proposed locations of supports and restraints to Delegated-Design Submittal details.

1.6 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the CBC unless requirements in this Section are more stringent.

B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel".

C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage pre-approved by ICC-ES, or preapproved by another agency acceptable to authorities having jurisdiction or pre-approval OPA number from OSHPD showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a State of California licensed structural engineer.

PART 2 - PRODUCTS

2.1 SEISMIC-RESTRAINT DEVICES

A. Basis-of-Design Product: Subject to compliance with requirements, provide products of Mason Industries or a comparable product by one of the following:

1. Cooper B-Line, Inc.; a division of Cooper Industries.

2. Hilti Inc.

3. Loos & Co.; Seismic Earthquake Division.

4. Mason Industries.

5. ISAT.

6. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components:

1. Components used in OSHPD Pre-Approval details: Use products according to OSHPD Pre-Approval details selected for this project.

2. Components used in Delegated-Design details: Rated strengths, features, and application requirements shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

2.2 FACTORY FINISHES

A. Finish: Manufacturer's standard paint or galvanized.

1. All hardware shall be galvanized. Hot-dip galvanized metal components for exterior use.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive seismic restraint devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing in of reinforcement and cast-in-place anchors to verify actual location before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATION

A. Multiple pipe supports: Secure piping to trapeze members with clamps according to OSHPD Pre-Approval details.

3.3 SEISMIC RESTRAINT DEVICE INSTALLATION

A. Install seismic restraint devices for distribution components according to Delegated-Design and OSHPD Pre-Approval details.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.

3.5 FIELD QUALITY CONTROL

A. Tests and Inspections: Test and inspect to meet regulatory requirements.

END OF SECTION

SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Valve tags.

1.3 QUALITY ASSURANCE

A. All tags and labels for medical gas piping systems shall be according to NFPA 99.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black. Red shall be used if the equipment is on emergency power.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 1-1/2 inch.
6. Minimum Letter Size: 1/2 inch Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Ceiling Grid Labels for concealed equipment and valves:

1. Coordinate label style (e.g. Kroy/P-Touch tape, color coded dots, etc.) with architect and owner.

C. Label Content: Include equipment's Drawing designation or unique equipment number, drawing numbers where equipment is indicated (plans, details, and schedules).

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper, tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Color and Lettering Size: Conform to ANSI/ASME A13.1-2015 standards.

D. Basis of Design manufacturer: Seton

2.3 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.

1. Stencil Material: Fiberboard or metal.

2. Stencil Paint: Exterior, gloss, enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
3. Identification Paint: Exterior, enamel in colors according to ASME A13.1 unless otherwise indicated.

2.4 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers. Valves shall be tagged per the chart below.

PIPING	VALVES
1. Cold Water	CW-1, CW-2, CW-3, etc.
2. Hot Water (Domestic)	HW-1, HW-2, HW-3, etc.
3. Hot Water Return (Domestic)	HR-1, HR-2, HR-3, etc.
4. Medical Air	MA-1, MA-2, MA-3, etc.
5. Medical Vacuum	MV-1, MV-2, MV-3, etc.
6. Nitrogen Gas	N2-1, N2-2,N2-3, etc.
7. Nitrous Oxide	NO-1, NO-2, NO-3, etc.
8. Oxygen	O2-1, O2-2, O2-3, etc.

1. For the systems not listed above, a similar naming strategy shall be utilized.
2. Tag Material: Brass, 0.032-inch minimum thickness, 1-1/2" minimum diameter and having predrilled or stamped holes for attachment hardware.
3. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper, tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.
2. Furnish a typewritten framed chart under glass indicating fixtures or areas supplied by each number valve and mount same as directed by Owner or Architect.

C. Ceiling Identification: Provide color coded dots on accessible ceiling grid to identify the location of valves mounted above the ceiling.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

C. All backflow preventers, vacuum breakers, mixing valves, hose stations, and trap primer manifolds shall also be labeled.

D. In addition to installing labels on each major item of mechanical equipment, adhesive labels shall be located on ceiling grids directly below equipment concealed in ceilings. Labels shall also be installed for all branch shutoff valves.

3.3 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Division 09. In the absence of specific requirements to the contrary in Division 9, all exposed equipment, piping, hangers, etc., shall be painted by the Contractor. Confirm with Owner the color scheme prior to commencing with painting. Unless otherwise directed, exposed piping shall be painted to match the structure and/or the surrounding areas. Should the Owner want each system shall be painted per system, follow the below schedule:

SYSTEM	COLOR
Domestic Hot Water	Yellow
Domestic Cold Water	Green
Sanitary Waste and Vent	Brown

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 20 feet along each run. Reduce intervals to 10 feet in areas of congested piping and equipment.
7. At least once in each room.
8. At each location where exposed piping passes through walls and floors.

3.4 VALVE-TAG INSTALLATION

A. Install tags on all valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; equipment shut-off valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

END OF SECTION

SECTION 22 07 00 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Insulation Materials
2. Adhesives.
3. Factory-applied jackets.
4. Tapes.
5. Protective Shielding Guards.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).

1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

C. Products shall not contain asbestos, lead, mercury, or mercury compounds.

D. All insulation materials furnished shall meet the minimum thickness requirement of ASHRAE standard 90.1.

E. Insulation materials for use on stainless steel shall be qualified as acceptable according to ASTM C 795.

F. Type 'R': Rigid (Molded) Fibrous glass, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ or with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Insulation without factory applied jacket shall be used in locations where field applied jackets are specified.
2. Products:

a. Owens Corning; Fiberglas Pipe Insulation SSL II-ASJ
b. Johns Manville; Micro-Lok
c. Knauf Insulation; 1000-Degree Pipe Insulation.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Mineral-Fiber and ASJ Adhesive: Comply with ASTM C916 Type I/II for bonding insulation jacket lap seams and joints.

1. Products:

a. Childers Products, H.B. Fuller Construction Products; CP-127 or CP-82.
b. Foster Products, H. B. Fuller Construction Products; 85-20 or 85-60.
c. Mon-Eco Industries, Inc.; 22-25.

2.3 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.4 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. ABI, Ideal Tape Division; 428 AWF ASJ.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
c. Compac Corporation; 104 and 105.
d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

2.5 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Manufacturers:

a. McGuire Manufacturing.
b. Oatey
c. Plumberex.
d. Truebro; a brand of IPS Corporation.
e. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.

2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.

B. If any insulation material has become wet because of transit or job site exposure to moisture or water, the contractor shall not install such material, and shall remove it from the job site.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with least number of joints practical.

I. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

J. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

K. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

L. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

M. All hot water piping shall be insulated up to every fixture stop.

3.3 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions while complying with firestopping requirements.

C. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.4 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the

bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

E. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

F. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.5 FIBERGLASS INSULATION INSTALLATION

A. Fiberglass Insulation: Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive and seal with vapor-barrier mastic and flashing sealant.

3.6 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces and other uninsulated building elements where the piping is not subject to freezing.
2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

C. All piping and equipment shall be insulated per the table below:

Service	Maximum Allowed Conductivity (Btu*in/(hr*ft²*F))	Insulation Type	Insulation Thickness According to Pipe Size			
			½" – ¾"	1" – 1 ¼ "	1 ½"	2" and Larger
Above Grade/Slab Hot Water and Hot Water Return 105-140°F	0.28	R	1	1	1-1/2	2

END OF SECTION

SECTION 22 08 00 - COMMISSIONING OF PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1. Refer to Division 01 General Requirements – Subgroup 019000 Life Cycle Activities, Specification Section 01 91 13 "General Commissioning Requirements" for the commissioning process requirements applicable to Division 22.

PART 2 - Not Used

PART 3 - Not Used

END OF SECTION

SECTION 22 11 16 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Domestic water piping and fittings inside the building and beneath the building slab.

2. Encasement for piping.

1.3 ACTION SUBMITTALS

A. Product Data: For the following products:

1. Piping materials including joining materials/methods.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner unless permitted in writing by the Owner only after arranging to provide temporary water service.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372. Plastic piping components shall be marked with "NSF-pw."

1. All plumbing components, including but not limited to piping, valves, backflow preventers, fixtures, etc that are connected to the domestic water system which convey water to be used for human consumption shall meet the NSF-372, 'Lead-Free' requirements. Items not intended to dispense water for human consumption such as flush valves, tub fills, shower valves, or piping accessories connected to non-potable water systems, are not required to meet the 'Lead Free' requirements.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper, for above ground applications. Below ground applications shall be ASTM B 88, Type K water tubing.

1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

5. Grooved-Joint Copper-Tube Appurtenances:

a. Acceptable Manufacturers:

1) Victaulic

b. Copper Grooved-End Fittings: ASME B16.22 wrought copper and ASTM B 75copper tube or ASME B16.18 and ASTM B 584 bronze castings. Fitting ends shall be manufactured to copper-tubing sizes. Flaring of tube or fitting ends to accommodate alternated sized couplings is not allowed. The product installation shall not require tightening the nuts to a specific torque rating. The basis of design is Victaulic Copper Connection.

c. Grooved-End-Tube Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections with offsetting angle-pattern bolt pads, Grade P fluoroelastomer gaskets with red and blue color code and suitable for hot and cold water, UL classified in accordance with NSF-61, and ASTM A449 bolts and nuts, with a minimum pressure rating of 300 psig. Components shall be installation ready, for direct push-on installation without field disassembly. The product installation shall not require tightening the nuts to a specific torque rating. The basis of design is Victaulic Style 607.

2.3 COPPER PIPE SLEEVE

A. Material: 10 mil. Polyethylene sleeve for protection in concrete pour.

1. Piping shall be cleaned prior to installation. Extend sleeve 6" above floor level. Tape ends shut to prevent entry of debris. Sleeve shall be installed on all copper piping passing through concrete floors and walls.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

F. Install piping adjacent to equipment and specialties to allow service and maintenance.

G. Install piping to permit valve servicing.

H. Install nipples, unions, special fittings, couplings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.

I. Install piping free of sags and bends.

J. Install unions at final connection to each piece of equipment, machine, and specialty. Install shut-off valves on the upstream side of the upstream union and downstream of the downstream union on each piece of equipment. Unions and flanges for servicing and disconnections are not required in installations with grooved mechanical joint couplings as the couplings shall serve as the disconnect points.

K. The system installation shall include all connections to plumbing fixtures, each piece of equipment and all equipment furnished under other contracts.

L. Piping shall be installed with necessary swing joints and offsets to properly allow for expansion in addition to expansion joints. Provide dielectic unions between steel and copper connections when copper pipe is installed.

M. Install all water pipe by use of proper pipe and fitting materials. All changes in pipe size shall be by use of reducing fittings. Bushings shall not be used.

N. All hot water systems shall be balanced by the contractor to ensure proper flow through each recirculating leg of the system including all mains back to the recirculation pump.

O. Piping is to run in the center of stud cavity wherever possible.

P. Do not install water piping in electrical rooms, tele/data rooms, transformer rooms, audio/visual rooms, or elevator equipment rooms.

Q. All piping shall be run full size as indicated on the drawings up to the equipment/fixture/device that it serves. Any change in size required for connection shall be made immediately adjacent to that equipment. All valves, unions, and associated devices serving the equipment shall be the same size as the pipe size indicated on the drawings serving that equipment.

R. Do not install tee fittings such that they are in the 'bullhead' orientation.

3.2 JOINT CONSTRUCTION

A. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

B. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

C. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

D. Copper-Tubing Grooved Joints: Roll groove end of tube. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for roll-grooved joints and in accordance with the manufacturer's latest published installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks. Gaskets shall be molded and produced by the coupling manufacturer, and shall be verified as suitable for the intended service. A factory-trained field representative (direct employee) of the mechanical joint manufacture shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. The factory-trained representative shall periodically review the product installation and ensure best practices are being followed. Contractor shall remove and replace any improperly installed products.

E. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.

C. Piping tests shall be performed per the requirements of the authority having jurisdiction. If the AHJ has no specific requirements, perform the following at a minimum:

1. Flush all piping prior to testing.
2. Fill domestic water piping with water. Check components to determine that they are not air bound and that piping is full of water.
3. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
4. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
5. Cap and subject piping to static water pressure of 100 psig above operating pressure, without exceeding pressure rating of piping system materials for 24 hours. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

a. Note: Some manufacturers of various system components, such as press fittings, require a lower pressure test. Should the contractor install any system components that the manufacturer specifically requires a lower pressure test, this shall be completed prior to that indicated here. The manufacturer's testing requirements shall be adhered to.

6. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
7. Prepare reports for tests and for corrective action required.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open throttling valves to proper setting.
3. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

a. Adjust calibrated balancing valves to flows indicated.

b. Provide a separate balancing report indicating the adjusted water balance flows.

4. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
5. Remove and clean strainer screens. Close drain valves and replace drain plugs.
6. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
7. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.5 CLEANING

A. Clean and disinfect domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system according to either of the following:

1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Submit water samples in sterile bottles to authorities having jurisdiction, should it be mandated by them. Repeat procedures if biological examination shows contamination.

B. Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Submit water samples in sterile bottles to authorities having jurisdiction, should it be mandated by them. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.6 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Above-ground domestic water piping, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and brazed or soldered joints.
2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
3. Hard copper tube, ASTM B 88, Type L; grooved-joint copper-tube appurtenances; and grooved joints (for piping NPS 2-1/2and larger).

C. Non-potable water (industrial water) shall be the same piping material as that listed above for the potable water.

END OF SECTION

SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following domestic water piping specialties:

1. Vacuum breakers.
2. Backflow preventers.
3. Balancing valves.
4. Water mixing valves.
5. Outlet boxes.
6. Hose bibbs.
7. Water hammer arresters.
8. Trap-seal primer valves.
9. Trap-seal primer electronic manifolds.

B. Related Sections include the following:

1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers, and pressure gages in domestic water piping.
2. Division 22 Section "Water Filtration Piping and Equipment" for water filters in domestic water piping.

1.3 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Hot water balancing report.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Items connected to the domestic water system shall be in compliance with NSF 61. Any plastic components connected to the domestic water system shall be in compliance with NSF 14.

1. All plumbing components, including but not limited to piping, valves, backflow preventers, fixtures, etc., that are connected to the domestic water system which convey water to be used for human consumption shall meet the NSF-372, 'Lead-Free' requirements. Items not intended to dispense water for human consumption such as flush valves, tub fills, shower valves, or piping accessories connected to non-potable water systems, are not required to meet the 'Lead Free' requirements.

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers shall meet ASSE 1001 and shall have a bronze body construction, size to match adjacent piping:

1. Manufacturers: Apollo Valve, FEBCO, Watts Industries, Wilkins.

B. Hose-Connection Vacuum Breakers shall meet ASSE 1011 and be a bronze body with garden house thread outlet:

1. Manufacturers: Watts Industries, Woodford, Wilkins.

C. Pressure Vacuum Breakers shall meet ASSE 1020, shall have a bronze body and shall be for use in continuous pressure applications and shall be provided with ball type shutoff valves on the inlet and outlet:

1. Manufacturers: Apollo Valve, FEBCO, Watts Industries, Wilkins.

2.2 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers shall meet ASSE 1013 with either bronze or stainless steel body (equal to that specified on the drawings), rated for continuous pressure applications, with ball or OS&Y valves on the inlet and outlet, and provided with an air gap fitting per ASME A112.1.2. On those located indoors, route the discharge from the air gap to the nearest floor receptor.

1. Manufacturers: Apollo Valve, FEBCO, Watts Industries, Mifab Wilkins.

B. Double-Check Backflow-Prevention Assemblies shall meet ASSE 1015 with either bronze or stainless steel body (equal to that specified on the drawings), rated for continuous pressure applications, with ball or OS&Y valves on the inlet and outlet:

1. Manufacturers: Apollo Valve, FEBCO; Watts Industries, Mifab, Wilkins.

C. Dual-Check-Valve Backflow Preventers shall meet ASSE 1024 with bronze body, union inlet, and rated for continuous pressure applications:

1. Manufacturers: Apollo Valve, FEBCO, Watts Industries, Wilkins.

2.3 BALANCING VALVES

A. Self-Acting Thermostatic Recirculation Valve Assembly:

1. Balancing valves shall be Circuit Solver as manufactured by Therm-Omega Tech model CSUAS-size-temperature-CV1-TW. No substitutions are allowed. Size shall be equal to the return pipe size it is being installed on and the temperature as indicated on the drawings.
2. Valves shall be self contained and fully automatic without additional piping or control mechanisms. Valving shall regulate the flow of recirculated domestic hot water based on temperature entering the valve regardless of system operating pressure. Even when closed, the valve shall bypass a small amount of hot water to maintain dynamic control of the recirculating loop. The valve shall be factory adjustable, and ranging in sizes for 1/2" to 1". The valve body and all internal components shall be constructed of stainless steel with major components being 303 stainless steel. Valve shall be rated to 200 psig working pressure and rated to 300 F maximum working temperature. Valving shall be NSF-61 certified for use in all domestic water systems. Thermal actuator shall be spring load loaded and self cleaning, delivering closing thrust sufficient to keep orifice opening free of scale deposits.
3. The assembly shall be entirely lead free, meeting NSF-61. The assembly shall be factory assembled and shall include (in order of flow) a full port ball valve, stainer, thermostatic balancing valve, union, swing check valve, thermometer, and another full port ball valve.

2.4 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Individual-Fixture, Water Tempering Valves:

1. Manufacturers:

a. Bradley Corporation
b. Leonard Valve Company.
c. Powers; a Watts Industries Co.

d. Symmons Industries Co.
e. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1070, thermostatically controlled water tempering valve.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
4. Body: Bronze body with corrosion-resistant interior components.
5. Temperature Control: Adjustable.
6. Inlets and Outlet: Threaded.
7. Finish: Rough or chrome-plated bronze. Chrome plating shall be utilized in all exposed areas, including below sinks.

2.5 OUTLET BOXES

A. Icemaker Outlet Boxes shall be furnished with brass quarter turn handled valve and factory installed water hammer arrester.

1. Manufacturers: Acorn Engineering, Guy Gray, IPS Corporation, Sioux Chief, Oatey.
2. Mounting: Recessed.
3. Material and Finish: As indicated on the fixture schedule and equal to the basis of design.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
5. Supply Shutoff Fitting: NPS 1/2 quarter turn ball valve.
6. Supply shall be provided with factory installed water hammer arrester.

2.6 HOSE BIBBS

A. Manufacturers: Zurn, Woodford, Jay R Smith, Prier.

B. Refer to the drawings for specifications.

C. All hose bibbs located in areas accessible to the public shall be furnished/installed with loose key operation unless specifically noted otherwise on the drawings.

2.7 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

1. Manufacturers: Sioux Chief.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.
5. Manufacturer's Warranty: Life of the system. Warranty shall be equal to that of Sioux Chief.

B. Air chambers shall not be used in lieu of water hammer arresters.

2.8 TRAP-SEAL PRIMER VALVES

A. Supply-Type, Trap-Seal Primer Valves:

1. Manufacturers: PPP Inc, Sioux Chief, Jay R Smith, Watts, Zurn.
2. Standard: ASSE 1018.
3. Device Pressure Rating: 125 psig minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.
8. Device shall operate off a 10 psig system pressure drop with a minimum system operating pressure of 20 psig.

2.9 TRAP-SEAL PRIMER ELECTRONIC MANIFOLDS

A. Electronic Trap-Seal Primer Systems meeting ASSE 1044:

1. Manufacturers: PPP Inc, Zurn, Mifab.
2. Anti-siphon atmospheric vacuum breaker meeting ASSE 1001.
3. Pre-set 24 hour clock with manual override switch.
4. Inlet and Outlet Connections: NPS 3/4 threaded.
5. Gravity Drain Outlet Connections: NPS 1/2 compression fitting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction. Backflow preventers shall be installed in accessible locations for testing purposes.

1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
3. Do not install bypass piping around backflow preventers.

B. Install balancing valves in locations where they can easily be adjusted.

C. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

1. Install thermometers and water regulators if specified.
2. Install cabinet-type units recessed in or surface mounted on wall as specified.

D. Install outlet boxes recessed in wall. Install 2-by-4-inch blocking wall reinforcement between studs.

E. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each circulator pump. Set calibrated balancing valves partly open to restrict but not stop flow.

F. Install wall hydrants and/or hose bibbs within manufacturer provided boxes in all front of house locations and areas adjacent to walkways.

G. Install water hammer arresters at every fixture or battery of fixtures which have quick-closing valves (i.e. lavatories, sinks, flush valves, dishwashers, ice machines, washing machines, solenoid valves.) Install per PDI-WH 201. Access panels are not required at arrestors, unless required by the AHJ.

1. Hammer arresters shall be installed directly to the header or branch piping serving the fixture(s) in which the water is flowing. Should the hammer arrester be provided with vertical nipples to elevate it above the piping (e.g. above a ceiling rather than within a wall cavity), directly under the arrestor a tee and normally closed shutoff valve shall be provided on the tee to allow for bleeding the air out of the piping once the system is filled. With this installation, as the system is filled, the air will fill the vertical piping and prevent the hammer arrester from working properly unless the air is bled from the system. Access shall be provided to bleed the air out of the system.

H. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

I. Install trap-seal primer manifolds with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Manifold shall be installed a minimum of 1 foot AFF for every 20 feet of horizontal primer piping.

J. Trap primer piping shall connect directly into the drain body or through a fitting in the tailpiece. Alternately, hub drains may be provided with the trap primer piping extending directly into the top of the drain. Tapping the side of the tailpiece or drilling a hole in the tailpiece to insert the trap primer piping is not acceptable.

K. Rough-in domestic water piping for water-meter installation and connect to the utility according to utility company's requirements. Provide shutoff valve on the inlet to the meter. Only install a bypass around the meter if required by the utility.

L. Install hose bibbs and wall hydrants 18” above finished grade/floor unless noted otherwise on the drawings.

M. Each public lavatory shall be provided with an ASSE 1070 thermostatic mixing valve set to limit the hot water supply temperature to no greater than 110 degrees F.

3.2 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves. Prepare and submit hot water balancing report.

C. Set field-adjustable temperature set points of thermostatic mixing valves.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:

1. Test each vacuum breaker and backflow preventer according to authorities having jurisdiction and the device's reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

END OF SECTION

SECTION 22 13 16 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following for soil, waste, and vent piping inside the building:

1. Pipe, tube, and fittings.
2. Special pipe fittings.

B. Related Sections include the following:

1. Division 22 Section “Hangers and Supports for Plumbing Piping and Equipment”
2. Division 22 Section “Sanitary Waste Piping Specialties”

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water.
2. Sanitary Sewer Force-Main Piping: 100 psig.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and fittings shall conform to ASTM A 888 and CISPI 301. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Pipe Institute.

1. Manufacturer's:

a. Charlotte Pipe and Foundry
b. Tyler Pipe
c. AB&I Foundry

B. Shielded Couplings: Assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.

1. Standard, Shielded, Stainless-Steel Couplings: CISPI 310 and ASTM C 1277 marked with NSF, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, neoprene sleeve.

a. Manufacturers: Anaco, Ideal, Fernco, Tyler Pipe, Mission, Clamp-All 80.

2. Medium-Duty, Shielded, Stainless-Steel Couplings: ASTM C1540 and FM 1680 Class 1, with stainless-steel shield, stainless-steel bands and tightening devices 5/16" hex head screws, and ASTM C 564, neoprene sleeve.

a. Manufacturers: Husky HD-2000, Clamp-All 125, Ideal Tridon Heavy Duty HD, Fernco Medium Duty, Mission Heavy Weight.

3. Heavy-Duty, Shielded, Stainless-Steel Couplings: ASTM C1540 and FM 1680 Class 1, with 304 stainless-steel shield, stainless-steel bands and tightening devices utilizing 3/8" hex head screws, and ASTM C 564, rubber sleeve.

a. Manufacturers: Husky SD-4000, Ideal Tridon Super-Heavy Duty HD, Fernco Heavy Duty.

2.2 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

B. Hard Copper Tube: ASTM B 88, Types L and M, water tube, drawn temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

C. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

B. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.

C. Install sleeves and mechanical sleeve seals as indicated in Section 22 05 00.

D. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

E. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

F. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

G. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:

1. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Vent Piping: Down toward fixture vent.

H. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

I. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

J. Install a complete sanitary drainage system. All soil, waste, and vent piping; connection to all plumbing fixtures, special equipment, floor drains and other equipment requiring such connections.

K. Verify all invert elevations and measurements prior to the installation of materials, either underground, above ground, or in the building.

L. Above slab sanitary and vent piping shall be supported from the building structure. Under no circumstances shall piping be supported from equipment, piping or conduits within the building structure.

M. All floor drains shall be set true and level and shall be protected properly throughout entire construction. Weep holes shall be filled with removable material, and kept free from concrete and other debris during construction. Weep holes shall be cleaned out for final working order. Safe with lead as specified. Resealing prime connections are required on all floor drains except floor drains located in showers.

N. Trap each fixture and piece of equipment requiring drainage connections. Traps shall be set true and level and located within the limits of the code requirements. Traps shall not be used as a separator, interceptor or other type of device to retain solids. All traps shall be provided with screw type approved cleanout plugs when specified. Traps shall be protected during construction and sealed off to prevent stones, debris and other foreign matter from entering before use. When running traps are used, they shall be located for full accessibility with double cleanout.

O. Provide plugs or caps for all opening during the construction phase. The temporary plug shall be plastic cap or equivalent. Duct tape is unacceptable for use as a plug, support or to separate ferrous from non-ferrous materials for the construction phase.

P. All vents through roof shall be installed a minimum of 10'-0" from all fresh air intake to air handling equipment and offset minimum of 3'-0" from edge of roof lines, parapets and all other flashing. Vent piping shall be collected so roof will be pierced a minimum number of times. Plumbing vents through roof shall be a minimum of 2 inches, or the minimum as required by code, whichever is more stringent. Vents through roof where located in a roof well, shall be extended so the vent is at an elevation above the top of the well. Vents through roof shall be painted with two coats of water based latex matching roof color.

Q. Clean-out plugs in piping shall be set with Teflon sealer or similar engineer approved equal.

R. Contractor shall coordinate with General Contractor to ensure floor drains are level with finished floor and finished floor is sloped in all directions toward floor drain.

S. Plastic piping shall not be used in plenum spaces unless UL listed for this application and approval is given by the AHJ.

T. Contractor is responsible for providing and installing all indirect waste piping that may be noted as such on another consultant's drawings (e.g. Kitchen Consultant drawings).

U. All indirect waste piping shall be terminated to be centered above the receptor opening serving it. The vertical indirect waste piping shall terminate with a mitered 45 degree cut,

sloping down and away from the inside radius of the adjacent elbow. Air gaps shall be two times the indirect waste pipe diameter.

3.2 PIPING APPLICATIONS

A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

B. Dissimilar Pipe-Material Couplings: Shielded, non-pressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

C. Aboveground, soil and waste piping shall be any of the following:
   1. Hubless cast-iron soil pipe and fittings; standard shielded, stainless-steel couplings; and hubless-coupling joints. Both sides of the elbow at the base of a stack of 3 stories or more as well as the first joint both upstream and downstream of the elbow, shall utilize heavy-duty no-hub couplings.

D. Aboveground, vent piping shall be any of the following:
   1. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.

E. Indirect Waste piping NPS 1 1/4 and smaller shall be any of the following:

   1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.

F. Indirect Waste piping NPS 1 1/2 and larger shall be any of the following:

   1. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
   2. Copper DWV tube, copper drainage fittings, and soldered joints.

3.3 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. During the test duration being a minimum of 15 minutes, the water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.4 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops. Duct tape is not an acceptable cap.

END OF SECTION

SECTION 22 13 19 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following sanitary drainage piping specialties:

1.

2. Cleanouts.

3. Floor and trench drains.

4. Miscellaneous sanitary drainage piping specialties.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification: Manufacturer's certification of seismic qualification according to ASCE 7. Submit ASCE 7 special seismic certification as required. Include method used to determine compliance with requirements.

1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Cast-Iron Floor Cleanouts (FCO):

1. Manufacturers: Josam, Jay R Smith, Wade, Watts, Zurn.

2. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.

3. Body Material: Cast iron.

4. Closure: Gas and watertight bronze plug with tapered threads with round scoriated secured cover.

5. Adjustable Housing Material: Cast iron with threads with shims for tilt correction.

6. Frame and Cover Material and Finish: Nickel-bronze.

7. Cleanout shall be equal to Zurn ZN1400-BZ1-BP.

B. Cast-Iron Wall Cleanouts (WCO):

1. Manufacturers: Josam, Jay R Smith, Wade, Watts, Zurn.

2. Standard: ASME A112.36.2M. Include wall access.

3. Body: cast-iron as required to match connected piping.

4. Closure: drilled-and-threaded bronze plug.

5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

6. Wall Access: Round, flat, stainless-steel cover plate with screw.

7. Cleanout shall be equal to Zurn Z1440-BP with Zurn Z1469.

2.2 FLOOR DRAINS, FLOOR SINKS, AND TRENCH DRAINS

A. Refer to Floor Drain Schedule on drawings for identification, materials, and options.

1. Manufacturers: Josam, Jay R Smith, MIFAB, Wade, Watts, Zurn.

2. If an approved manufacturer other than that specified is submitted, all options specified on the drawings shall be provided on the submitted floor drain.

2.3 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.

2. Body: Bronze or cast iron.

3. Inlet: Opening in top of body.

4. Outlet: Larger than inlet.

5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with mounting and anchoring requirements for seismic installations.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.

2. Locate at each change in direction of piping greater than 45 degrees.

3. Locate at minimum intervals of 100 feet .

4. Locate at base of each vertical soil and waste stack.

C. Provide a cleanout at the end of the run of each horizontal pipe serving wall hung water closets. The cleanout and associated piping serving it shall rise above the elevation of the seat of the water closets.

D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

F. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless detailed otherwise by the architect.

1. Position floor drains for easy access and maintenance.

2. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.

G. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.

H. Install air-gap fittings on indirect-waste piping discharge into sanitary drainage system.

I. Install traps on drain outlets. Omit traps on indirect wastes unless trap is indicated.

J. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

K. Install sleeve waterproofing device on all piping sleeves through floors that do not require a fire rating.

3.2 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops. Duct tape is not an acceptable plug or cap.

END OF SECTION

SECTION 22 40 00 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes all conventional plumbing fixtures and related components.

B. Related Sections include the following:

1. Division 22 Section "Domestic Water Piping Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.
2. Division 22 Section "Emergency Plumbing Fixtures."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For all fixtures to include in operation and maintenance manuals. Include information on the servicing and adjustment of all fixtures.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

3. Flush Valve, Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than 12 of each type.
4. Provide hinged-top wood or metal box, or individual metal boxes, with separate compartments for each type and size of extra materials listed above.
5. Flushometer Tank (pressure-assist), Repair Kits: Equal to 5 percent of amount of each type installed, but no fewer than 2 of each type.
6. Water-Closet Tank, Repair Kits: Equal to 5 percent of amount of each type installed.
7. Toilet Seats: Equal to 5 percent of amount of each type installed.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer. However, if fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Regulatory Requirements: Comply with requirements in ANSI A117.1, "Accessible and Usable Buildings and Facilities" for plumbing fixtures for people with disabilities.

C. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

D. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.

E. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants" for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.

F. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1. All plumbing components, including but not limited to piping, valves, backflow preventers, fixtures, etc that are connected to the domestic water system which convey water to be used for human consumption shall meet the NSF-372, 'Lead-Free' requirements. Items not intended to dispense water for human consumption such as flush valves, tub fills, shower valves, or piping accessories connected to non-potable water systems, are not required to meet the 'Lead Free' requirements.

G. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

H. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.

2. Plastic Mop-Service Basins: ANSI Z124.6.
3. Plastic Shower Enclosures and receptors: ANSI Z124.2.
4. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
5. Slip-Resistant Bathing Surfaces: ASTM F 462.
6. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
7. Stainless-Steel Commercial, Handwash Sinks: NSF 2 construction.
8. Vitreous-China Fixtures: ASME A112.19.2M.

I. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
4. Faucets: ASME A112.18.1.
5. Hose-Connection Vacuum Breakers: ASSE 1011.
6. Hose-Coupling Threads: ASME B1.20.7.
7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
8. Pipe Threads: ASME B1.20.1.
9. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
10. Supply Fittings: ASME A112.18.1.
11. Brass Waste Fittings: ASME A112.18.2.

J. Comply with the following applicable standards and other requirements specified for shower faucets:

1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
3. Deck-Mounted Bath/Shower Transfer Valves: ASME 18.7.
4. Faucets: ASME A112.18.1.
5. Hand-Held Showers: ASSE 1014.
6. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
7. Hose-Coupling Threads: ASME B1.20.7.
8. Manual-Control Antiscald Faucets: ASTM F 444.
9. Pipe Threads: ASME B1.20.1.
10. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
11. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
12. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.

K. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

1. Atmospheric Vacuum Breakers: ASSE 1001.
2. Brass and Copper Supplies: ASME A112.18.1.
3. Dishwasher Air-Gap Fittings: ASSE 1021.

4. Manual-Operation Flushometers: ASSE 1037.
5. Brass Waste Fittings: ASME A112.18.2.
6. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.

L. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Disposers: ASSE 1008 and UL 430.
2. Flexible Water Connectors: ASME A112.18.6.
3. Floor Drains: ASME A112.6.3.
4. Hose-Coupling Threads: ASME B1.20.7.
5. Hot-Water Dispensers: ASSE 1023 and UL 499.
6. Off-Floor Fixture Supports: ASME A112.6.1M.
7. Pipe Threads: ASME B1.20.1.
8. Plastic Toilet Seats: ANSI Z124.5.
9. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.7 WARRANTY

A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures of unit shell.
b. Faulty operation of controls, blowers, pumps, heaters, and timers.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period for Commercial Applications: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 FIXTURES

A. All fixtures basis of design is listed on the drawings. The following manufacturers are approved subject to compliance with the requirements listed on the drawings.]

1. Lavatory faucets: American Standard, Chicago Faucets, Kohler, Moen, Sloan, Symmons, Zurn.
2. Bathtub/shower faucets: Delta, Kohler, Moen, Powers, Symmons, Zurn.
3. Sink faucets: American Standard, Chicago Faucets, Delta, Elkay, Grohe, Kohler, Moen, Sloan, Zurn, Sloan, T&S Brass.
4. Flush valves: Kohler, Sloan, Zurn, Hydrotek, American Standard.

5. Toilet seats: American Standard, Bemis, Centoco, Church, Kohler, Olsonite.
6. Protective shielding guards: McGuire, Plumberex, TRUEBRO, Zurn, Dearborn, Oatey.
7. Fixture supports: Josam, MIFAB, Jay R Smith, Watts, Zurn.
8. Water closets: American Standard, Kohler, Sloan, TOTO USA, Zurn.
9. Urinals: American Standard, Kohler, Sloan, TOTO USA, Zurn.
10. Lavatories: American Standard, Kohler, Sloan, TOTO USA.
11. Commercial sinks: Elkay, Just.
12. Individual showers: Aqua Glass, Florestone, LASCO, Swan, Aqua Bath.
13. Kitchen sinks: Kohler, American Standard, Elkay, Just.
14. Bar sinks: Kohler, American Standard, Elkay, Just.
15. Service sinks: American Standard, Kohler, Fiat, Stern Williams.
16. Service basins: Acorn, Fiat, Stern-Williams.
17. Shower receptors: Florestone, LASCO, American Standard, Jacuzzi, Kohler, Acorn.
18. Disposers: In-Sink-Erator; KitchenAid.
19. Hot water dispensers: In-Sink-Erator, Elkay, KitchenAid.
20. Drinking fountains & water coolers: Filtrine, Halsey Taylor, Haws, Oasis, Sunroc, Elkay.
21. Clinical sinks: American Standard, Kohler, Zurn.
22. Fixture stops, tailpieces, traps, etc: Zurn, JR Smith, McGuire, Brasscraft, Josam, Sioux Chief

B. Unless specifically specified otherwise on the drawings, provide fixtures with the following:

1. Sinks and Lavatories

   a. 17 gauge brass polished chrome tailpiece, trap, and escutcheon.
   b. Brass polished chrome quarter turn angle stops.
   c. Braided stainless steel supply hoses.

2. Shower valves:

   a. Screwdriver stops

3. Flush valves

   a. Solid ring pipe support

4. Water Closet Seats

   a. All public toilet seats shall be provided less lid with an open front seat.
   b. Seats within residential/dwelling unit type spaces (residences, apartments, condos, and hotel rooms) shall be provided with closed front seat with a lid.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install wall-mounting fixtures with tubular waste piping attached to supports.

D. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

E. Install all fixtures level and plumb according to roughing-in drawings.

F. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

G. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

H. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

I. Install flush valves and trip levers for accessible water closets and urinals with handle mounted on wide side of compartment.

J. Install trap-seal liquid in dry urinals.

K. Install faucet-spout and flow-control fittings with specified flow rates and patterns.

L. Install shower flow-control fittings with specified maximum flow rates in shower arms.

M. Install disposer in outlet of each sink indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.

N. Install dishwasher air-gap fitting at each sink indicated to have air-gap fitting. Install in sink deck or on countertop at sink. Connect inlet hose to dishwasher and outlet hose to disposer.

O. Install hot-water dispensers in back top surface of sink or in countertop with spout over sink.

P. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."

Q. Unless otherwise noted in Division 7, seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color.

R. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

3.2 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.3 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at faucets and flush valves to produce proper flow and stream.

C. Replace washers and seals of leaking and dripping faucets and stops.

D. Adjust drinking fountains for proper temperature setting and the flow regulators for proper flow and stream height.

E. Install fresh batteries in sensor-operated mechanisms.

F. Adjust sensor angle and range on sensor-operated faucets and flush valves for proper operation.

3.4 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.5 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 22 63 13 - MEDICAL GAS PIPING FOR HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes medical gas piping. Medical gas piping includes the following:

1. Medical air piping and specialties designated "medical air."
2. Nitrous oxide piping, designated "medical nitrous oxide."
3. Oxygen piping, designated "medical oxygen."
4. Medical-surgical vacuum piping, designated "medical vacuum."
5. Waste anesthetic gas disposal piping, designated "WAGD."

B. Owner-Furnished Material:

1. Bulk medical gas storage tanks.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Seismic Qualification: Manufacturer’s certification of seismic qualification according to ASCE 7. Submit ASCE 7 special seismic certification as required. Include method used to determine compliance with requirements.

1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For medical gas piping specialties to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Quick-Coupler Service Connections: Furnish complete non-interchangeable medical gas pressure outlets and suction inlets equal to 3 percent of amount installed, but no fewer than 2 units.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Medical Gas Piping Systems for Healthcare Facilities: According to ASSE Standard #6010 for medical-gas-system installers.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.

1. Qualify testing personnel according to ASSE Standard #6020 for medical-gas-system inspectors and ASSE Standard #6030 for medical-gas-system verifiers.

C. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

D. Source Limitations: Obtain medical gas service outlets of same type and from same manufacturer as service outlets provided for in Division 22 Section "Gas Piping for Healthcare Facilities."

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with NFPA 99, "Health Care Facilities," for medical gas system materials and installation in healthcare facilities.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Medical air operating at 50 to 55 psig.

B. Medical nitrous oxide operating at 50 to 55 psig.

C. Medical oxygen operating at 50 to 55 psig.

D. Medical vacuum operating at 19 in. Hg.

E. WAGD operating at 19 in. Hg.

2.2 PIPES, TUBES, AND FITTINGS

A. Copper Medical Gas Tube: ASTM B 819, Types K and L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," in green for Type K tube and in blue for Type L tube.

1. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type that has been manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.

2. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.

B. Copper Water Tube: ASTM B 88, Type K, seamless, drawn temper.

C. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service.

D. Copper Unions: ASME B16.22 or MSS SP-123, wrought-copper or cast-copper alloy.

E. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150.

1. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness, full-face type.

2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

2.3 JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.

B. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

2.4 VALVES

A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.

B. Manufacturers:

1. Allied Healthcare Products, Inc.;

2. Amico Corporation.

3. BeaconMedaes.

C. Ball Valves: 3-piece body, bronze.

1. Pressure Rating: 600 psig minimum.

2. Ball: Full-port, chrome-plated brass.

3. Seats: PTFE or TFE.

4. Handle: Lever type.

5. Stem: Blowout proof with PTFE or TFE seal.

6. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

D. Check Valves: In-line pattern, bronze.

1. Pressure Rating: 300 psig minimum.

2. Operation: Spring loaded.

3. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

E. Zone Valve Box Assemblies: Box with medical gas valves, tube extensions, and gages.

1. Description: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.

2. Interior Finish: Factory-applied white enamel.

3. Cover Plate: Aluminum or stainless steel with frangible or removable windows.

4. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

5. Valve: 3-piece-body, bronze ball valve with gage

a. Pressure Rating: 600 psig minimum.

b. Ball: Full-port, chrome-plated brass.

c. Seats: PTFE or TFE.

d. Handle: Lever.

e. Stem: Blowout proof with PTFE or TFE seal.

f. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

g. Pressure Gage: Manufacturer installed on one copper-tube extension.

F. Safety Valves:

1. Bronze-body

2. ASME-construction, poppet, pressure-relief type

3. Settings to match system requirements.

G. Pressure Regulators:

1. Bronze body and trim

2. Spring-loaded, diaphragm-operated relieving type

3. Manual pressure-setting adjustment

4. Rated for 250-psig minimum inlet pressure

5. Capable of controlling delivered air pressure within 0.5 psig for each 10-psig inlet pressure.

2.5 MEDICAL GAS SERVICE OUTLETS

A. Manufacturers:

1. Allied Healthcare Products, Inc.

a. Hospital standard outlets are Chemetron by Allied Healthcare Products, Inc. and the intent is to match the building standard.

B. Connection Devices: For specific medical gas pressure and service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.

C. Roughing-in Assembly:

1. Steel outlet box for recessed mounting and concealed piping.

2. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed.

3. Double seals that will prevent air leakage.

4. ASTM B 819, copper outlet tube brazed to valve with service marking and tube-end dust cap.

D. Finishing Assembly:

1. Brass housing with primary check valve.

2. Double seals that will prevent air leakage.

3. Cover plate with gas-service label.

E. Quick-Coupler Service outlets:

1. Pressure outlets/inlets with noninterchangeable keyed indexing to prevent interchange between services

2. Constructed to permit one-handed connection and removal of equipment.

3. With positive-locking ring that retains equipment stem in valve during use.

F. Cover Plates: One piece, aluminum or stainless steel and permanent, color-coded, identifying label matching corresponding service.

2.6 FLEXIBLE PIPE CONNECTORS

A. Manufacturers:

1. Flexicraft Industries.

2. Mercer Rubber Co.

3. Metraflex, Inc.

B. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

1. Working-Pressure Rating: 250 psig minimum.

2. End Connections: Threaded copper pipe or plain-end copper tube.

PART 3 - EXECUTION

3.1 PREPARATION

A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:

1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1.

2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.

a. Scrub to ensure complete cleaning.

b. Rinse with clean, hot water to remove cleaning solution.

3.2 PIPING INSTALLATION

A. Comply with NFPA 99 for installation of medical gas piping.

B. Comply with mounting and anchoring requirements for seismic installations.

C. Install eccentric reducers, if available, where medical gas piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

D. Install branch connections to medical gas mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

E. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping."

F. Install piping to permit valve servicing. Valving shall not be located more than 48” above suspended ceilings.

G. Install medical gas service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.

H. Connect medical gas piping to equipment and/or manifolds and to medical gas outlets and equipment requiring it.

I. Install unions adjacent to each valve at the final connection to each machine, specialty, and piece of equipment.

J. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

K. Install exterior, buried medical gas piping in protective conduit fabricated with PVC pipe and fittings. Do not extend conduit through foundation wall.

3.3 VALVE INSTALLATION

A. Install shutoff valve at each connection to and from medical gas equipment and specialties.

B. Install check valves to maintain correct direction of flow from medical gas equipment.

C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.

D. Install zone valves and gages in valve boxes. Arrange valves so largest valve is lowest. Rotate valves to angle that prevents closure of cover when valve is in closed position.

E. Install pressure regulators on medical gas piping where reduced pressure is required.

F. Install flexible pipe connectors in discharge piping and in inlet air piping from remote air-inlet filter of each air compressor and vacuum pump.

3.4 JOINT CONSTRUCTION

A. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.

B. Threaded Joints: Apply appropriate tape to external pipe threads.

C. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" chapter. Continuously purge joint with oil-free dry nitrogen during brazing.

D. Extruded-Tee Outlets: Form branches in copper tube according to ASTM F 2014, with tools recommended by tube manufacturer.

3.5 GAS SERVICE COMPONENT INSTALLATION

A. Assemble patient-service console with service connections. Install with supplies concealed in walls. Attach console box or mounting bracket to substrate.

B. Assemble ceiling columns and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.

C. Assemble ceiling-hose assemblies and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.

3.6 IDENTIFICATION

A. Install identifying labels and devices for medical gas piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:

1. Medical Air: Black letters on yellow background.

2. Nitrous Oxide: White letters on blue background.

3. Oxygen: White letters on green background or green letters on white background.

4. Medical Vacuum: Black letters on white background.

5. WAGD: White letters on violet background.

B. Identify all zone valve boxes for the area that they serve. All identification shall be neat and professional. All tags shall meet the requirements of Division 22 Section 'Identification for Plumbing Piping and Equipment' and NFPA 99.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Medical Gas Piping Testing Coordination: Perform tests, inspections, verifications, and certification of medical gas piping systems concurrently with tests, inspections, and certification of medical air and medical vacuum piping systems.

2. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:

a. Initial blow down.

b. Initial pressure test.

c. Cross-connection test.

d. Piping purge test.

e. Standing pressure test for positive-pressure medical gas piping.

f. Standing pressure test for vacuum systems.

g. Repair leaks and retest until no leaks exist.

3. System Verification: Perform the following tests and inspections according to NFPA 99, ASSE Standard #6020, and ASSE Standard #6030:

a. Standing pressure test.

b. Individual-pressurization or pressure-differential cross-connection test.

c. Valve test.

d. Master and area alarm tests.

e. Piping purge test.

f. Piping particulate test.

g. Piping purity test.

h. Final tie-in test.

i. Operational pressure test.

j. Operational vacuum test.

k. Medical air purity test.

l. Medical gas concentration test.

m. Verify correct labeling of equipment and components.

n. Verify medical gas supply sources.

4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:

a. Inspections performed.

b. Procedures, materials, and gases used.

c. Test methods used.

d. Results of tests.

C. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.8 PROTECTION

A. Protect tubing from damage.

B. Retain sealing plugs in tubing, fittings, and specialties until installation.

C. Clean tubing not properly sealed, and where sealing is damaged, according to "Preparation" Article.

3.9 PIPING SCHEDULE

A. Flanges may be used where connection to flanged equipment is required.

B. Above Ground Medical Gas Piping: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

3.10 DEMONSTRATION

A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain medical gas systems and equipment. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 22 64 00 - MEDICAL GAS ALARMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Area alarm panels.
2. Local alarm panels.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For alarm panels and system components to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Qualify Installers for air, vacuum, and gas piping systems for healthcare facilities according to ASSE Standard #6010 for medical-gas-system installers.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the air, vacuum, and gas piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.

1. Qualify testing personnel for air, vacuum, and gas piping systems for healthcare facilities according to ASSE Standard #6020 for medical-gas-system inspectors and ASSE Standard #6030 for medical-gas-system verifiers.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Gas and Vacuum Systems Monitored:

1. Medical compressed air, designated “medical air.”
2. Medical-surgical vacuum, designated "medical vacuum."
3. Nitrous oxide, designated "medical nitrous oxide."
4. Oxygen, designated "medical oxygen."
5. Waste anesthetic gas disposal, designated "WAGD."

2.2 MANUFACTURERS

A. Manufacturers:

1. Amico Corporation.
2. Allied Healthcare Products, Inc.
3. BeaconMedaes.
4. Powerex.
5. Ohio Medical Corporation.

B. Source Limitations: Obtain medical alarm systems and components from single manufacturer.

C. Hospital standard manufacturer for Alarm Panels is Amico Corporation and the intent is to match this standard.

2.3 GENERAL REQUIREMENTS FOR ALARM PANELS

A. Description: Factory wired with audible and color-coded visible signals to indicate specified functions.

1. Mounting: Recessed installation.
2. Enclosures: Fabricated from minimum 0.047-inch-thick steel or minimum 0.05-inch-thick aluminum, with knockouts for electrical and piping connections.
3. Alarm: Red alarm LED light shall illuminate and the audible alarm shall sound. Alarm shall be a minimum of 80 dB at the source. Pushing the ‘alarm silence’ button will silence the audible alarm but the unit will remain in alarm condition until the problem is rectified.
4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.

C. Dew Point Monitors: Continuous line monitoring, having panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, factory- or field-installed valved bypass, and visual and cancelable audio signal for dryer site and master alarm panels. Alarm signals when pressure dew point rises above 35 deg F at 55 psig.

1. Operation: Chilled-mirror method or hygrometer moisture analyzer with sensor probe.

D. Pressure Switches or Transducer Sensors: NEMA 4 housing with continuous line monitoring with electrical connections for alarm system.

1. Low-Pressure Operating Range: 0.5 to 80 psig.
2. High-Pressure Operating Range: Up to 250 psig.

E. Vacuum Switches or Pressure Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.

1. Vacuum Operating Range: 0.8 to 29 in. Hg.

F. All Medical Gas Alarm panels shall be listed to UL 1069 for Hospital Signaling Equipment as an assembly and shall include factory wiring, transformers, and circuitry requiring only 115 or 230 volt primary power.

G. The alarm shall arrive on the job site pre-configured as shown on the drawings and schedules or shall be configured by MGEM personnel at no additional charge.

H. Alarm shall supervise its wiring to sensors and switches, indicating at the relevant panel(s) if any wire is cut, disconnected or open.

I. Each scheduled signal displays the condition monitored. Activation of any switch will change the display, and actuate the audio alarm.

J. The digital alarm panels, with the basis of design being the Beacon Madaes TotalAlert Infinity system, shall have the following characteristics:

1. Alarm shall have a LCD touch screen display to allow for all alarm programming and set up on site without the use of tools.
2. Master alarm panels shall be fully compatible with owner's Ethernet network as supplied.
3. Alarm panels shall allow users to set up customized instructions for each alarm signal, to appear on the screen when the signal is in alarm.
4. Customized instructions to be created with the touch screen interface on the alarm panel LCD. Alarm to incorporate user-defined instructions into an emergency response plan by the facility.
5. Event log accessible on LCD display records alarms and panel activity, displays most recent 100 events. Event log is downloadable through embedded web page, including most recent 1000 events.
6. Capability to capture and display (mirror) digital readings (pressure/vacuum levels) and source signals from other TotalAlert Infinity™ alarm panels via Ethernet

7. Capability to customize alarm instructions on mirrored pressures and signals, enabling unique instructions at each panel
8. All panels utilizing the built-in Ethernet connection capable for BACNet transmission of signals to a Building Automation System, no additional software or hardware required.
9. Alarms employ the TCP/IP family of protocols for communication and each device has a unique IP address
10. Alarm panel conforms to the BACnet protocol and includes a Protocol Implementation Conformance Statement (PICS)
11. Alarm panels equipped with WiFi 802.11 b/g/n interface to provide access with any web enabled device to panel web page and retrieve operating information and event history
12. With 4-20mA option, set up any 2 or 3 wire 4-20mA transducer with user defined values
13. Ability to customize badges through the touchscreen interface to display the 4-20mA readings, including color, identification, location, value settings, and alarm set points (high and low), and customized alarm instructions
14. Each 4-20mA monitored condition shows a separate green display when NORMAL and a red display when in ALARM

2.4 AREA ALARM PANELS

A. Area Alarm Panels: Separate trouble alarm signals and indicators for each system.

1. Standards: Comply with NFPA 99 and UL 544.

2. The sensor module shall contain a transducer capable of providing calibrated signals to the digital module. Sensor modules shall be gas specific and capable of mounting directly in the gas pipeline system, either in the ceiling or within the zone valve cabinet. Pipeline connections shall be 3/8" nominal copper tubing. Connectors shall be provided for attaching field wiring. Sensors shall be capable of being removed without shutting down the medical gas system.
3. Include alarm signals as required by NFPA 99.

2.5 LOCAL ALARM PANELS

A. Local Alarm Panels: Separate trouble alarm signals and indicators for each system.

1. Standards: Comply with NFPA 99 and UL 544.
2. Include alarm signals as required by NFPA 99.

PART 3 - EXECUTION

3.1 ALARM-PANEL INSTALLATION

A. Install alarm panels in locations required by and according to NFPA 99.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Division 22 Section "Medical Gas Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to alarm panels, allow space for service and maintenance.

C. Install the building automation system interface per the manufacturer’s instructions. All components in the facility including air compressors, vacuum pumps, manifolds, bulk tanks, area alarms, and master alarms shall all be connected.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment" and according to NFPA 99.

B. Identify each area alarm panel with the area that it serves. All labeling shall be neat and professional.

C. Identify each signal on the master alarm panel for the item it monitors. All labeling shall be neat and professional.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Alarm panels will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Perform startup service and complete installation and startup checks according to manufacturer's written instructions.

3.6 ADJUSTING

A. Adjust initial alarm panel pressure and vacuum set points.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain alarm panels and related devices.

B. Contractor and/or manufacturer’s representative shall train the owner’s maintenance personnel on how to program the alarm messages. The contractor and manufacturer’s representative shall perform the initial programming of all panels.

END OF SECTION

DIVISION 23

HEATING, VENTILATING, AND AIR CONDITIONING

SECTION 23 05 00 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Division 07 Section “Penetration Firestopping” for piping, conduit and wiring penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies and smoke barriers.

C. Division 07 "Roof Accessories" and "Sheet Metal Flashing and Trim" for piping, conduit and equipment supports penetrating roofs, exterior walls and floors including flashings, curbs, sealants, clamps and vents.

1.2 SUMMARY

A. This Section includes the following:

1. Grout.
2. Flashing materials.
3. Equipment installation requirements common to equipment sections.
4. Painting and finishing.
5. Concrete bases.
6. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.4 SCOPE

A. Drawings and Specifications form complementary requirements; provide work specified and not shown, and work shown and not specified as though explicitly required by both. Although work may not be specifically shown or specified, provide supplementary or miscellaneous items, appurtenances, devices and materials obviously necessary for a sound, secure and complete installation.

B. It is the intent that these Specifications and associated Drawings establish minimum requirements for products and equipment with the intent to provide HVAC systems finished, tested and ready for operation. Incidental detail that is not shown or specified, but necessary for proper installation and operation shall be included in the work and in these Contractor's estimates, the same as if specified. Locations of all equipment and material shall be adjusted at no extra cost to the Owner, to accommodate the work interferences anticipated and/or encountered. Prior to installation, determine the exact route and location of each pipe, duct and piece of equipment to minimize conflicts with other trades.

C. This project may be phased, as defined by the Owner. This may necessitate the provision of temporary valving and capping of existing utilities or HVAC systems. All associated appurtenances with the utilities shall be provided as part of this project in the appropriate phase coordinated with Owner’s phasing requirements.

D. It is the requirement of these Contract Documents to have the contractors provide systems and components that are fully complete, operational and suitable for the intended use. There may be situations in the documents where insufficient information exists to precisely describe a certain component or subsystem, or the routing of a component or its coordination with other building elements. In cases such as this, where the Contractor has failed to notify the Architect of the situation the Contractor shall include the specific components or subsystems with all parts necessary for the intended use, fully complete and operational, and installed in workmanlike manner either concealed or exposed per the design intent.

1.5 MODIFICATIONS IN LAYOUT

A. Drawings are intended to outline the scope of work required and are not intended to be installation drawings. Drawings are not intended to be absolutely precise; they are not intended to specify or to show every offset, fitting, and component nor do they show the exact routing and locations needed to coordinate with structure and other trades and to meet Architectural requirements. The purpose of the drawings is to indicate a systems concept, the main components of the systems, and the approximate geometrical relationships. Based on the systems concept, the main components, and the approximate

geometrical relationships, the contractor shall provide all other components and materials necessary to make the systems fully complete and operational.

B. Unless specifically stated to the contrary, no measurement of a drawing derived by scaling shall be used as a dimension to work by. Dimensions noted on the drawings are subject to measurements of adjacent and previously completed work. Measurements shall be performed prior to the actual installation of equipment.

C. Prior to installation of visible material and equipment (including access panels) in finished spaces, review Architectural Drawings for desired locations and where not definitely indicated, request information from Architect.

D. Check Contract Documents, as well as, Submittals and Shop Drawings of all subcontractors to verify and coordinate spaces in which work of Divisions 21 through 28 will be installed.

E. Make reasonable modifications in layout and components needed to prevent conflict with work of other trades. Systems shall be run parallel with or perpendicular to major architectural and structural building elements.

F. Where conflicts or potential conflicts exist and engineering guidance is desired, submit sketch of proposed resolution to Architect for review and approval.

1.6 COORDINATION

A. Coordinate arrangement, mounting, and support of piping and equipment:

1. To maintain maximum headroom; all piping, duct, conduit and associated components to be as tight as possible to underside of structure to provide for ease of disconnecting the equipment with minimum interference to other installations.
2. To allow right of way for piping installed at required slope.
3. To be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for HVAC items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

1.7 RECORD DOCUMENTS

A. Record Drawings are specified in Division 01 Section "Project Record Documents."

B. The Contractor shall keep a detailed up-to-date record, of the manner and location in which installations are actually made, indexing pipe, duct, and piece of equipment. Record documents are to reflect all changes in work including change orders, field directives, addenda from bid set of Contract Documents, request for information responses, etc.

Upon completion of the project, the contractor shall modify the project electronic drawing and specification files to incorporate this information. Modified documents shall be turned over to the Owner in both electronic and hard paper copy formats. Record drawings shall also include:

1. Locations of buried piping or similar items. Include buried depth.
2. Field changes of dimension or detail.
3. Changes made by field order or change order.
4. Details not on original contract drawings.

1.8 MAINTENANCE MANUALS AND OPERATING INSTRUCTIONS

A. Obtain at time of purchase of equipment, three copies of operation, lubrication and maintenance manuals for all items. Assemble literature in a coordinated manual. Manual shall contain names and addresses of manufacturers and local representatives who stock or furnish repair parts for items or equipment.

B. The manuals shall include the following and shall have an index of contents and tabs for each Specification Section and each piece of equipment specified in that Section and be provided in the order listed below, per Specification Section.

1. Copies of all approved submittals/shop drawings.
2. Manufacturer's operating and maintenance instructions and parts lists of all items or equipment. Where manufacturer's data includes several types or models, the applicable type or model shall be clearly designated.
3. Startup and shutdown procedures.
4. Flow diagrams.
5. Test records.
6. Wiring diagrams.
7. Lubrication instructions detailing type of lubricant, amount, and intervals recommended by manufacturer for each item of equipment.
8. Owner's written acknowledgement of satisfactory completion of instruction period.

C. Furnish three copies of manuals to Architect for approval and distribution to Owner. Deliver manuals no less than 30 days prior to acceptance of equipment to permit Owner's personnel to become familiar with equipment and operation prior to acceptance.

D. Operating instructions: Upon completion of installation or when Owner accepts portions of building and equipment for operational use, instruct Owner's operating personnel in any or all parts of all systems. Factory-trained personnel shall perform instructions.

1.9 SUBMITTAL PROCEDURE AND FORMAT

A. This Article supplements Division 1.

B. Submittal Cover Sheet

1. Submittal data for each product shall include a copy of the following cover sheet completely filled out. Incomplete or incorrect cover sheet submittal shall constitute reason for rejection.
2. Material submittals shall be organized by specification section. All items requiring a submittal per each specification section shall be combined into a single submittal. Provide each section/item within that submittal with its own cover sheet labeled and tagged to match the drawings.

SHOP DRAWING COVER SHEET				
PROJECT:		CONTRACTOR:		
DIVISION NO.:		SECTION NO.:		
DESCRIPTION:				
CONTRACT DRAWING REFERENCE NO.:				
EQUIPMENT TAG:				
SUBMISSION (CIRCLE ONE): FIRST, SECOND, THIRD, FOURTH				
DATE:				
INFORMATION AND CHECKLIST:				
1.	Contractor's Log #ID			
2.	Name, address, and phone number of supplier.			
3.	Are all specified or scheduled items included and exactly match scheduled/specified items?	Yes	No	
4.	Is this item a substitution?	Yes	No	
5.	Are deviations clearly identified?	Yes	No	
6.	Does equipment fit space shown on construction documents, coordination drawings, and actual field conditions?	Yes	No	
7.	Has support, erection, weights, and installation been coordinated with all trades?	Yes	No	
8.	Does the proposed installation void warranties and/or violate UL or code requirements?	Yes	No	
9.	Does this material/equipment add expense to any other trade or project costs?	Yes	No	
10.	Does equipment require interface with other trades? List divisions and specifics requiring coordination?	Yes	No	
11.	Is control interface coordinated?	Yes	No	

12.	List electrical characteristics (V/Ph/A)			

C. Multiple Re-submittals: The Engineer will review the first submittal from the contractor and respond with comments, and will review one re-submittal for the same item(s) from the contractor and respond with comments. If the contractor is required to make subsequent submittals for the same item(s) the Engineer shall be compensated by the contractor for the time to review each subsequent re-submittal. The contractor shall agree to compensate the Engineer a minimum of $500 per each re-submittal item.

D. Shop Drawings showing layouts of systems shall contain sufficient plans, elevations, sections, details and schematics to describe work clearly. They shall be 1/4 inches = 1 foot 0 inch scale unless specified otherwise.

E. Shop drawings and submittals showing manufacturer's product data shall contain detailed dimensional drawings, accurate and complete description of materials of construction, manufacturer's published performance characteristics and capacity ratings (performance data, alone, is not acceptable), electrical requirements and wiring diagrams. Drawings shall clearly indicate location (terminal block or wire number), voltage and function for all field terminations, and other information necessary to demonstrate compliance with all requirements of Contract Documents.

F. Provide shop drawing submittals showing details of piping connections to ALL equipment. If connection details are not submitted and connections are found to be installed incorrectly in the field, this contractor shall reinstall them within the original contract price.

G. Shop drawings for different systems and equipment shall be bound separately by specification section as indicated above and not bound by manufacturer. Each separate submittal shall have its own transmittal and cover letter. Submittals which contain different specification section systems bound together may be returned un-reviewed for re-submittal.

1.10 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Electrical Characteristics for HVAC Equipment: Equipment of different electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified at the contractor’s expense. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

C. All electrical components, devices and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use. Skid-mounted or packaged assemblies shall be listed and labeled as an assembly, not just the individual components.

D. Fire-Resistance Ratings: For piping, conduit and wiring penetrations, provide penetration firestopping devices tested for fire resistance per ASTM E 814 by a testing agency acceptable to authorities having jurisdiction. Indicate design designations from UL's "Fire Resistance Directory."

E. Acceptable Manufacturers

1. The Engineer's design for each product is based on the manufacturer listed in the schedule or shown on the drawings. In Part 2 of some technical specifications, other manufacturers are listed as being acceptable. The listing of a manufacturer as acceptable does not imply automatic approval. It is the sole responsibility of the Contractor to ensure that any submittals made are for products that meet or exceed the specifications included herein. These are acceptable only if, as a minimum, they:

a. Meet all performance criteria listed in the schedules and outlined in the specification.
b. Have identical operating characteristics to those called for in the specification. For example, a two-stroke diesel generator will not be acceptable if a four-stroke model is specified.
c. Fit within the available space it was designed for, including space for maintenance and component removal, with no modification to either the space or the product. Clearances to walls, ceilings and other equipment will be at least equal to those shown on the design drawings. The fact that a manufacturer's name appears as acceptable shall not be taken to mean that the Engineer has determined that the manufacturer's products will fit within the available space - this determination is solely the responsibility of the contractor.
d. Products must adhere to all architectural considerations including but not limited to: being of the same color as the product scheduled or specified, fitting within architectural enclosures and details, and for diffusers, lighting and plumbing fixtures - being the same size and of the same physical appearance as scheduled or specified products.
e. All equipment shall be labeled or listed by the National Board of Underwriters Laboratories (U.L.) where such labeling or listing exists for such material.

1.11 TEMPORARY SERVICES/CONTINUITY OF UTILITY SERVICES

A. In the absence of specific requirements in Division 1, comply with the following procedures for shut-downs.

B. Provide temporary services where project construction schedule requires extended shut downs of existing equipment and/or systems. Temporary services include the necessary equipment and/or systems to maintain continuity of services. Extended shut downs are interruptions of existing services for a period of time longer than that acceptable to the Owner.

C. Contractor shall coordinate any shutdowns of existing systems as follows:

1. Give proper notice to Owner when making shutdowns; a minimum of fourteen full days is required.
2. Minimize timeline of shutdowns of any system.
3. Provide temporary services where required and perform shutdowns and tie-ins at a time convenient to Owner.
4. Contractor shall be responsible for completing and filing the Owner's shutdown notice questionnaire.
5. Perform required survey and inspection work required by the notice for shutdown.
6. All life safety systems shall be returned to service at the end of each work day, when work is being performed on the systems. It is the responsibility of the Contractor to provide all associated appurtenances necessary to ensure that the systems are in proper working condition at all times.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Protect equipment/materials from damage during shipping, storage, handling and installation. Delivery equipment/materials to the site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

B. The Contractor shall provide for enclosed storage, when equipment/materials are stored on-site and prior to building "dry-in", to prevent any damage resulting from inclement weather or construction traffic. Specialties shall not be stored outdoors.

C. Equipment/materials, stored or installed, found to be damaged shall be replaced with new by the Contractor, to the satisfaction of the Owner and at no additional expense. Do not store equipment with PVC material with exposure to direct sunlight.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection. This is applicable for all Division 23 sections.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.3 FLASHING MATERIALS

A. All piping, conduit and equipment supports through roofs shall be flashed. Flashing materials and methods shall be in accordance to the roof manufacturer's and Division 07 requirements.

PART 3 - EXECUTION

3.1 PRE-BID SITE VISIT

A. Before submitting bid, visit and carefully examine site to identify existing conditions and difficulties that will affect work of this division. No extra payment will be allowed for additional work caused by unfamiliarity with site conditions that are visible or readily construed by an experienced observer.

B. Contractor shall visit job site to familiarize himself with the specific location of the new equipment installations in existing areas, to ensure there is adequate access for the installation of equipment. All entries, pathways, corridors, stairwells, etc., that may be used to install equipment shall be investigated. All existing conditions and potential obstructions that may impede access and installation shall be addressed prior to equipment purchasing/ordering.

C. The documentation of existing conditions was derived from As-Built documents and are in part unverified. Actual existing conditions shall be verified prior to commencement of work.

3.2 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. All equipment shall be installed per the manufacturer's installation requirements.

B. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

D. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

E. Install equipment to allow right of way for piping installed at required slope.

F. If it is determined that in order to install equipment in an existing space, disassembling of the equipment will be required, the Architect shall be notified immediately, prior to ordering equipment. Confirmation that equipment factory warranties will not be voided shall be confirmed in writing. Arrangements for factory-authorized assembly at the job site shall then be made and be considered part of the construction cost.

3.3 PAINTING

A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.4 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.

C. Field Welding: Comply with AWS D1.1.

D. Fireproofing:

1. Clips, hangers, clamps, supports and other attachments to surfaces to be fireproofed shall be installed, insofar as possible, prior to start of spray fiber work.
2. Piping and other items which would interfere with proper application of fireproofing shall be installed after completion of spray fiber work.
3. Patching and repairing of fireproofing due to cutting or damaging to fireproofing during course of work specified under this Section shall be performed by installer of fireproofing and paid for by trade responsible for damage and shall not constitute grounds for extra cost to Owner.

3.5 GROUTING

A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

3.6 WELDING

A. Weld only by approved acetylene or electric welding processes and welders shall hold certificate from approved insurance company.

B. Conduct test to demonstrate suitability of procedures to be used in making welds, which conform to specified requirements.

C. Specification for welding procedure shall meet requirements of Welding Qualifications, Section IX, ASME Boiler and Pressure Vessel Code and ANSI B31.1.

D. Align components. No strain shall be placed on weld during welding. No part of pipe shall be offset more than 20% of thickness. Set flanges and branches properly.

E. Welder and Brazing Qualification:

1. Test welders to demonstrate ability to make acceptable welds. Tests conducted for qualification of welder for work under one Division or Section shall not necessarily qualify welder for work under another Division or Section.
2. Tests shall be as prescribed for welder qualification in Section IX of the ASME code.
3. Records of such tests shall be as follows: Each welder shall be assigned an identifying number, letter or symbol. Identifying mark shall be stamped adjacent to welds made by this welder. Identification shall be at top of horizontal piping and at front of vertical piping.
4. Maintain record of welders employed, showing dates and results of tests and identifying mark assigned to each welder. Certify records and make them accessible to Owner's project representative and/or project manager. Before completion of project, one copy of records shall be turned over to Owner.
5. No qualification shall be older than three years when welder commences work on this project. If welder has not welded in required welding process for a period of six months, he shall be re-certified.

F. Welding Tests

1. As designated by Architect, remove welds for destructive testing or for testing by non-destructive means. Tests shall be as determined by Architect.
2. If, in Architect's opinion, welds so tested do not meet requirements of Sections VIII and IX of ASME, then the Contractor shall pay for the costs of the tests. Remove welds welded by that welder, at no cost to the Owner. Rewelding shall be performed by qualified welder other than welder whose welds did not pass test. Welders whose welds were defective shall not be employed on site for remainder of project.

3. Welding of stanchions, brackets, anchors and other welding not performed on pipe joints shall be in accordance with requirements of AWS specifications and requirements.

3.7 INSTALLATION ONLY ITEMS:

A. Where this contractor is required to install items which he does not purchase, he shall coordinate their delivery and be responsible for their unloading from delivery vehicles and for their safe handling and field storage up to the time of installation. This contractor shall be responsible for:

1. Any necessary field assembly and internal connections, as well as mounting in place of the items, including the purchase and installation of all dunnage supporting members and fastenings necessary to adapt them to architectural and structural conditions.
2. Their connection to building systems including the purchase and installation of all terminating fittings necessary to adapt and connect them to the building systems.

B. This Contractor shall carefully examine such items upon delivery. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of work of this Contractor will be considered only if presented in writing within one week of their date of delivery. Unless such claims have been submitted, this Contractor shall be fully responsible for the complete reconditioning or replacement of the damaged items.

3.8 PIPING SYSTEMS – COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping to permit valve servicing.

E. Install escutcheons for exposed piping penetrations of walls, ceilings and floors.

F. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe, conduit and wiring penetrations. Seal penetrations with fire- and smoke-stop materials. Refer to Division 07 for firestopping and fill materials.

G. Waterproof Penetrations: Maintain integrity of waterproof roof, wall and floor penetrations for pipe, conduit and equipment support penetrations. Seal penetrations with waterproof materials with clamps, sleeves, flashings, pipe boots and/or pipe curb assemblies as detailed or specified. Refer to Division 07 for waterproofing methods and materials when not specified in this section.

H. If, after project is in operation, any piping systems, coils or other apparatus are stratified or air bound (by vacuum or pressure), they shall be re-piped with new approved and necessary fittings, air vents, or vacuum breakers at no extra cost to the Owner. If connections are concealed in furring, floors, or ceilings, this trade shall bear all expenses of cutting, patching and refinishing construction and finish, leaving same in as good condition as before it was disturbed.

3.9 CLEANING

A. Cleaning shall be performed prior to system start-up.

B. Ductwork

1. Ducts shall be thoroughly cleaned so that no dirt or dust will be discharged from diffusers, registers or grilles, when system is operated.
2. Clean all ductwork both internally and externally to remove all dirt, plaster dust or other foreign materials. When external surfaces of ductwork are rusted, clean and restore surfaces to original condition.
3. Provide temporary connections required for cleaning. Provide cheesecloth for openings during cleaning.
4. Replace filters prior to final inspection and testing.

C. Piping

1. General:

a. After all piping systems have been pressure tested and approved for tightness, flush and clean piping as specified and as required by codes.
b. Furnish pipe cleaning chemicals, chemical feed equipment, materials and labor necessary to flush and clean piping.
c. Permanently install necessary chemical injection fittings complete with stop valves.
d. Monitor the water temperatures and prevent the heat generated by the pump circulating the water from causing the water temperature to exceed the temperature ratings of the pipe, pumps, and other components of the piping system during the flushing and cleaning process.
e. Contractor to provide a portable temporary pumping apparatus for the purpose of flushing and cleaning. Pump shall be adequate to provide the required velocities necessary for the process.
f. When external surfaces of piping are rusted, clean and restore surfaces to original condition.

2. Flushing:

   a. All water side equipment control valves, strainers, etc., shall be bypassed prior to and during the flushing process.
   b. Flush all water, steam and condensate systems clear of all dirt and foreign matter with all pumps bypassed. All flushing to be at a circulation rate of 6 f.p.s.
   c. Maintain continuous blowdown and make-up, as required during flushing operation.
   d. Once flushing is complete and prior to cleaning, all final connections to equipment shall be performed.
   e. Water samples taken from the system during flushing shall determine when the system is ready for the cleaning process.

3. Cleaning:

   a. Clean all pipeline strainer baskets and return to original condition or replace with new baskets prior to the pipe cleaning process.
   b. The cleaning chemicals shall be designed to remove deposition from construction, such as pipe dope, oils, loose mill scale, and other extraneous silt and mud. The products shall inhibit corrosion of the various metals in the system and shall be safe to handle and use with normal chemical safety equipment, i.e., gloves and safety glasses. Effectiveness of the product shall be such that the water need only be at ambient temperatures.
   c. During the cleaning procedure, remove strainers, automatic air vents, flow regulators and any other item that would be affected by the clean and flush procedure. All control valves and coils should be set up for wide open, full flow.
   d. After initial flushing of a system, use portable pumping apparatus for a continuous 24 hour circulation of a cold water detergent equal to Nalco 2567 cleaner.
   e. After circulating for the prescribed time, systems shall then be drained and flushed until the total alkalinity or conductivity of the rinse water is not more than 20% higher than the readings for the make-up water. Refill with clean water and treat with scale and corrosion inhibitor. Contractor shall furnish the chemicals, supervise the cleaning, test the water after flushing, and shall provide a report that certifies successful cleaning and flushing of the piping.

3.10 COMMISSIONING

A. The Commissioning Authority will be Owner furnished and under direct contract with the Owner. That is, the General Contractor and this subcontractor's bid price shall not include the services of the Commissioning Authority but shall include costs for coordination testing, Contractor commissioning, etc.

END OF SECTION

SECTION 23 05 10 – HVAC DEMOLITION AND ALTERATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:

1. Disconnection of mechanical equipment in selected portions of building or structure.
2. Demolition and removal of selected mechanical components.
3. Salvage of existing items to be reused or recycled.

B. Related Requirements:

1. Division 01 Section "Cutting and Patching."
2. Division 02 Section “Selective Structure Demolition” for sequencing and scheduling procedures and requirements for demolition activities.

1.3 JOB CONDITIONS

A. Perform all demolition as needed to accomplish new work.

B. Do not rely solely on mechanical drawings to determine extent of general construction demolition. Refer to architectural demolition plans for the exact extent of general construction demolition required by this contract.

C. This Contractor is responsible for all charges, fees etc. incurred as a result of the mechanical portion of the demolition.

D. Prior to demolition or alteration of structures, the following shall be accomplished:

1. Review available record documents of the existing construction. Owner does not guarantee that existing conditions are same as those indicated in record documents.
2. Coordinate sequencing with Owner and other Contractors.
3. Coordinate means to separate construction zones from non-renovated zones to prevent the spread of dust, fumes and debris.
4. Coordinate means to provide exhaust and makeup air to maintain the construction zone at an adequate negative pressure to contain all construction dust and fumes.

5. Except as noted otherwise, remove from the premises, all materials and equipment removed in the demolition work.
6. Equipment noted to be removed and turned over to the Owner, shall be delivered to the Owner at a place and time he so designates.
7. Where the materials are to be turned over to the Owner or reused and installed by the Contractor, it shall be the Contractor's responsibility to maintain the condition of the materials and equipment equal to that existing before work began. Damaged materials or equipment shall be repaired or replaced at no additional cost to the Owner.
8. Survey and record condition of existing facilities to remain in place that may be affected by demolition operations. After demolition operations are completed, survey conditions again and restore existing facilities to their pre-demolition condition, at no additional cost to Owner.
9. Salvage equipment scheduled for reuse in new work or scheduled to be delivered to Owner's storage facility.

PART 2 - PRODUCTS
Not used.

PART 3 - EXECUTION

3.1 DEMOLITION

A. Existing mechanical equipment in conflict with new construction shall be removed and/or relocated as indicated on the drawings, as directed or needed. This Contractor shall remove all mechanical equipment released from service as a result of construction, and no equipment removed shall be reused, except as specifically directed on the drawings or elsewhere herein. All mechanical components shall be stored on site for Owner assessment. Any components not retained by the Owner shall be removed by the contractor. Properly dispose or remove from site any items not retained by Owner.

B. Any existing services or equipment not shown on the drawings and which are logically expected to be continued in service and which may be interrupted or disturbed during construction, shall be reconnected in an approved manner. Provide temporary ducts, pipes, controls, etc., as needed to prevent interruption of service to occupied areas caused by demolition operations. In addition, any ductwork, piping or equipment which may require relocation or rerouting as a result of construction, shall be considered a part of the work of this section and shall be done by this Contractor with no additional compensation, provided that the referenced relocation is discernable from the pre-bid review of the site, and associated documents.

C. This Contractor shall remove all ductwork, piping, straps, and existing equipment, being discontinued or removed due to construction. Abandoned or removed services shall be disconnected and capped at the perimeter of the project or as required elsewhere in the documents.

D. The existing building is to remain in operation during construction. This Contractor shall coordinate all work including shutdowns for removing or adding equipment that will interfere with the present operation of the facility with the Owner and Construction Manager.

E. All existing equipment that is to remain shall be cleaned inside and out. Clean all pipeline strainer baskets and return to original condition or replace with new baskets. All dirt, plaster dust and other foreign matter shall be blown and/or cleaned from coils, terminal devices, diffusers, registers, and grilles. Touch up paint equipment in exposed areas.

F. Ductwork systems indicated to remain shall be wiped or vacuumed clean both internally and externally to remove all dirt, plaster dust or other foreign materials.

G. Existing ductwork systems that are being extended or modified to serve this project shall be cleaned inside and out in accordance with the National Air Duct Cleaners Association (NADCA) standards. This includes the addition of access panels necessary to reach the complete duct system back to its air handling unit or fan.

H. Existing ductwork in remodeled area that is not being removed shall be sealed as necessary to comply with SMACNA standards and requirements of ductwork section of the specifications.

I. All coring that is required for mechanical work shall be done by this Contractor.

J. All cutting and patching required for mechanical work shall be by this Contractor.

K. This Contractor shall provide required additional support for existing ductwork and piping in remodeled area that is not being removed and is not properly supported.

L. When existing ductwork, piping, or related equipment in remodeled areas prevents the installation of other work, remove and reinstall existing materials, making necessary modifications and transitions to coordinate with other trades.

M. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed unless noted otherwise.

1. Components to Be Removed: Remove associated HVAC system components including all associated piping, ductwork, supports, grilles, power and controls.
2. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
3. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
4. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
5. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
6. Equipment to Be Removed: Disconnect and cap services and remove equipment.

7. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
8. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

N. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

O. Contractor shall verify that all equipment to be re-used is in satisfactory and functional condition. Notify the architect and engineer of any deficiencies before removing the equipment.

P. The contractor shall perform testing of any air or hydronic system that is to be modified to identify existing flows and pressures. These values shall be used to return flows in sections to remain to pre-renovation values after the renovation.

3.2 CLEANING AND REPAIR

A. Clean existing materials and equipment which remain or are to be reused. Report damage or defects to Architect

3.3 TESTING

A. Existing equipment shall be tested before demolition begins to determine existing operating conditions and capacities. The existing equipment shall be rebalanced to serve the new areas and maintain existing capacities in existing areas per the work sequence as shown on drawings.

END OF SECTION

SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors or electronically commutated (ECM or EC) motor for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

B. Related Sections Include:

1. Division 26 Section “Enclosed Switches and Circuit Breakers”.
2. Division 26 Section "Enclosed Controllers”

1.3 DEFINITIONS

A. ODP: Open Drip Proof

B. TEFC: Totally Enclosed Fan Cooled

C. TEAO: Totally Enclosed Air Over

D. EC Motor: electronically commutated motor

E. VFD: Variable frequency drive (motor controller)

F. Service Factor: A multiplier to motor’s nameplate rated power as an indicator of overload rating.

1.4 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.

3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

B. Provide all motors, power transformers, control power transformers and all electrically powered or electrically controlled equipment.

C. Drawings and/or specifications show number and horsepower rating of all motors, together with their actuating devices. Should any change in size, horsepower rating or means of control be made to any motor or other electrical equipment after the contracts are awarded, Division 23 Contractor is to immediately notify General Contractor of change. Any additional costs due to these changes shall be the responsibility of Division 23 Contractor.

D. Division 26 Contractor will provide power wiring to starter, disconnect and motor and connect all equipment complete and ready to operate. Division 23 Contractor shall provide all control wiring line and low voltage, including temperature control wiring and associated conduit for all control wiring.

E. Wire all equipment associated with this contract, including interlock wiring, except wiring which is scheduled to be done by others.

F. Provide wiring diagrams to Division 26 Contractor for all apparatus indicating external connection and internal controls.

1.5 STARTERS, VFD's, AND DISCONNECTS BY DIVISION 23

A. All VFDs required for the control of motors or electrical equipment shall be furnished by Division 23 and installed by Division 26 contractor, except as specifically noted elsewhere in these specifications.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or individual specification sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

C. Select motors for conditions in which they will be required to perform; i.e., general purpose, splashproof, explosion proof, standard duty, high torque, or any other special type as required by the manufacturer's recommendations.

1. Furnish ODP Motors for indoor non-hazardous environments.
2. Furnish motors with splash proof or weatherproof housing where required or recommended by the manufacturer.

3. Furnish TEFC motors for exposed outdoor installations and corrosive environments.
4. Furnish TEAO motors when located in airstream of equipment serving corrosive environments.
5. Furnish Severe Duty motors complying with IEEE-841 standards for severe duty and hazardous locations.

D. All motors shall be furnished for starting in accordance with utility requirements, and shall be compatible with starters, as specified under Division 26 specifications.

E. Motors located inside air handling units in a clean airstream may be ODP motors.

2.2 MOTOR CHARACTERISTICS

A. Refer to the equipment schedules and specification sections for specific voltages required.

B. All motors shall be 1750 RPM, unless otherwise noted and selected to operate at or below nameplate amps.

C. Polyphase motors for direct drive applications with variable frequency drives with bypass feature shall be selected at a speed equal to or less than the design speed of the fan or pump. Motors shall be selected to allow operation at full speed and on bypass at 60 hertz without exceeding nameplate ratings.

D. Motors 1 horsepower and larger shall be premium efficiency or EC permanent magnet type.

E. Motors shall meet or exceed efficiency levels per energy code for intended duty.

F. Duty: Continuous duty at ambient temperature of 104 deg F and at altitude of 3300 feetabove sea level.

G. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at full speed, at installed altitude and environment, with indicated operating sequence and design criteria without exceeding nameplate ratings or considering service factor.

H. Provide electronically commutation (EC) single or three phase permanent magnet motors with integral EC motor controller or polyphase motors with variable frequency drive for variable speed applications. Speed control by 0-10 VDC signal or dial mounted potentiometer for automatic control and test and balance.

I. EC motors shall be selected to allow full speed operation without exceeding nameplate amp rating.

2.3 PREMIUM EFFICIENCY POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

1. Efficiency: Meet or exceed the most stringent of the applicable Energy Code, NEMA Premium efficiency standards, as defined in NEMA MG 1 or the efficiencies listed below when tested in accordance with IEEE Standard 112, Method B procedures as stated in NEMA MG 1-12.53a.

	Open Drip-Proof			Totally Enclosed Fan-Cooled		
Number of Poles	6-pole	4-pole	2-pole	6-pole	4-pole	2-pole
RPM	1200	1800	3600	1200	1800	3600
HP						
1	82.5	85.5	77.0	82.5	85.5	77.0
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2	87.5	86.5	85.5	88.5	86.5	85.5
3	88.5	89.5	85.5	89.5	89.5	86.5
5	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10	91.7	91.7	89.5	91.0	91.7	90.2

B. Service Factor: 1.15.

C. Multispeed Motors: Separate winding for each speed.

D. Rotor: Random-wound, squirrel cage.

E. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

F. Temperature Rise: Class B.

G. Insulation: Class F.

H. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

I. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

J. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

K. Motors Used with Variable Frequency Drives: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
3. Thermal Protection: Comply with NEMA MG 1 Part 31 requirements for thermally protected motors.
4. Motors connected to variable frequency drives shall have shaft grounding devices meeting the following requirements.

    a. Shaft grounding shall be a bearing isolator, or labyrinth seal, that includes a built-in grounding ring and brush. The brush shall contain conductive microfibers that completely surround the shaft to discharge any current flowing through it.
    b. Motors less than 100 HP size shall be provided with a single shaft grounding ring provided on the drive end of the motor.
    c. Motors 100 HP size and larger shall be provided with a shaft grounding ring on both ends of the motor shaft or shall have an insulated ceramic bearing installed on the non-drive end of the motor and a shaft grounding ring installed on the drive end of the motor.
    d. Apply a fast drying silver paint on the shaft surface to prevent corrosion.
    e. Shaft grounding ring wear shall be less than 0.001" in 10,000 hours with a fiber wear length designed for expected life 200,000+ hours based on testing. Shaft grounding rings shall be compatible with operating environments ranging from -40° F to 300° F and 0-90% RH (non-condensing).
    f. AEGIS SGR™ Bearing Protection Ring as manufactured by Electro Static Technology (EST).

2.4 SINGLE-PHASE MOTORS

A. Motors 1 HP and below shall be single-phase motors minimum 70% efficient to 1/12 HP, unless scheduled otherwise.

B. Motors shall be one of the following types as required for the application and/or as scheduled, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Capacitor start, capacitor run.
3. Electronic commutation (EC).

C. Multispeed Motors: Variable-torque, permanent-split-capacitor type or electronic commutation type.

D. Variable Speed applications: Electronic commutation type.

E. Bearings: Permanently lubricated and sealed, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading. Motors 1/8 HP and below may be shaded pole type with permanently oiled unit bearings.

F. Thermal Protection: Internal thermal overload protection for single phase motors to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

G. Separate Overload Device: Manufacture to include a fused controller or other separate overload device integral to the equipment for motors without internal thermal overload protection.

H. EC Motors: Motors to be brushless DC electronically commutated permanent magnet type designed for direct drive applications with minimum 80% efficiency at all speed settings. Factory mounted integral motor controller with transformer and speed control down to 20% full speed utilizing a 0-10 VDC signal. Motor controller includes factory programming, user interface, operational status indicators and motor status switch.

1. For constant volume applications, speed controller to be either integral or remote mounted speed controller manual dial type potentiometer.
2. For variable volume applications, motor speed shall be automatically controlled by a 0-10 VDC signal from the control system.

2.5 POLYPHASE EC MOTOR

A. Motors to be three phase brushless DC electronically commutated permanent magnet type designed for direct drive applications with operation to 20% full speed. Factory mounted integral motor controller with transformer, controls, user interface and integrated power factor correction for low input harmonic current distortion.

B. Efficiency of EC motor at full speed and part speed to meet or exceed the efficiency levels as specified above for premium efficiency polyphase induction motors.

C. Maintenance-free sealed ball bearings with long term lubrication.

D. Insulation Class: “F” or better.

E. NEMA motor frames or axial flux design for compact plenum fans.

F. EC motor PID integral motor controller to include:

1. Speed control utilizing a 0-10 VDC signal
2. Fan status switch.
3. Motor current limit.
4. User interface via BAS and wireless network portable user device.
5. RS485/MODBUS network interface.
6. Overcurrent and over temperature protection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install materials in accordance with details, approved shop drawings, and manufacturer's instructions.

B. Verify thermal overload or overcurrent protection is provided for motors.

END OF SECTION

SECTION 23 05 23 - GENERAL-DUTY VALVES FOR HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bronze Ball valves
2. Calibrated Balancing Valves
3. Automatic Flow Control Valves

B. Related Sections include:

1. Division 23 Section “Hydronic Piping”.
2. Division 23 Section “Hydronic Piping Specialties”.

1.2 PERFORMANCE REQUIREMENTS

A. Products shall be suitable for the indicated service including piping system fluids, materials, pressures, and temperatures.

B. Hydronic valves and installation shall withstand the minimum design pressure and temperature and test pressure as specified in Division 23 Section “Hydronic Piping.”

1.3 DEFINITIONS

A. EPDM: Ethylene propylene copolymer rubber.

B. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

C. NRS: Nonrising stem.

D. OS&Y: Outside screw and yoke.

E. RS: Rising stem.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve indicated, provide product data including applicable dimensions, capacities, materials of construction, non-compatible fluids and pressure and temperature ratings.

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

1. Grooved end valves shall be of the same manufacturer as the adjoining couplings

B. Hydronic piping and valves shall be fabricated and installed to comply with ASME.

C. Qualification Data: Submit proof of qualifications specified in Quality Assurance article.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle and globe valves closed to prevent rattling.
4. Set ball valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Hydronic valves and installation shall be suitable for indicated service with design pressure and temperature ratings as indicated in Part 1 “Performance Requirement” Article.

B. Hydronic piping, valves and installation shall withstand 1.5 times the system’s working pressure for pressure test requirements.

C. Finish: Manufacturer’s standard paint or galvanized construction to resist corrosion for valves constructed of steel.

D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

E. Obtain each type of valve from single source from single manufacturer.

F. MANUFACTURERS: For ball valves, gate valves, check valves, and butterfly valves, Powell, Apollo, Bray, Crane, Nibco, Jenkins, Hammond, Stockham, Red-White Valve Corp., Lunkenheimer, Milwaukee, Mueller Steam, Kitz and Victaulic. For other valves, acceptable manufacturers are listed under each item.

G. Valve Sizes: Same as upstream piping unless otherwise indicated.

H. Valve Actuator Types:

1. Handwheel: For valves other than quarter-turn types.
2. Handlever: For quarter-turn valves NPS 6and smaller except plug valves.
3. Memory Stop: Include manufacturer's memory stop for all manual balancing valves and for butterfly valves used as balancing valves.

I. Valves in Insulated Piping: With stem extensions and the following features:

1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

J. Valve-End Connections:

1. Threaded ends for NPS 2 and smaller.
2. Valve ends may be pressure seal or grooved when specified for fittings in Hydronic Piping.
3. Drain, vent and blow down valves NPS ¾ and smaller: provide with ¾" hose end connection with cap and chain, unless piping is extended to drain.
4. Drain, vent and blow down valves NPS 1 to NPS 2: provide with line size cap or plug, unless piping is extended to drain.
5. Future pipe connections all sizes: provide line sized isolation valve with spool piece and end cap.

2.2 BALL VALVES

A. Bronze Two-Piece Full-Port Ball Valves for NPS 2 and smaller:

1. Description:

a. Standard: MSS SP-110.
b. Body Design: Two piece
c. Body Material: Bronze
d. Seats: PTFE or TFE.
e. Stem: Bronze or stainless
f. Ball: Chrome-plated brass or stainless
g. Port: Full

2.3 CALIBRATED BALANCING VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bell & Gossett Domestic Pump; a division of ITT Industries.
2. Flow Design
3. Griswold Controls
4. Hays Fluid Controls
5. Oventrop Corporation
6. Red-White Valve Corp
7. Taco
8. Victaulic

B. Venturi Balancing Valve NPS 2 (DN50) and smaller:

1. Description:

a. Body Design: Ball type 1-piece valve with calibrated venturi
b. Body Material: Bronze
c. Valve: Suitable for shut off
d. Seat: PTFE
e. End Connections: Threaded
f. Stem: Bronze or Stainless
g. Ball: Chrome-plated brass or stainless
h. Port: Full
i. Pressure Gage Connections: Integral seals for portable differential pressure meter
j. Handle Style: Lever, with memory stop to retain set position
k. Venturi: Low pressure loss high pressure signal type
l. Accuracy: Plus or minus 3%
m. Insulation: Shipping container dsigned for use as insulation with minimum R of 4.5 and 25/50 fire smoke rating.

2.4 AUTOMATIC FLOW-CONTROL VALVES:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bell & Gossett Domestic Pump; a division of ITT Industries.
2. Flow Design Inc.
3. Griswold Controls.
4. Hays Fluid Controls.
5. Oventrop Corporation.
6. Red-White Valve Corp.
7. Victaulic Company.

B. Automatic Flow-Control Valve NPS 2 1/2 (DN65) and smaller:

1. Description:

a. Body Design: Flow limiting type with offset screwed cap to allow removal of flow limiting cartridge without disconnecting piping.
b. Optional GPM dial: Integral GPM dial to allow field adjustment of cartridge and maximum GPM without changing cartridge.
c. Body: Brass.
d. Cartridge: Brass Body, 304 Stainless steel spring, EPDM seals non clogging design where cartridge never fully seats.
e. End Connections: Threaded.
f. Pressure Gage Connections: Integral seals for portable differential pressure meter.
g. Accuracy: Plus or minus 5% over an operating pressure differential of 2 psi to 32 psi.
h. Capacity: Select the GPM for 10% more than listed in the equipment schedules.
i. Optional combination Assemblies: Include integral bonze ball valve.
j. Insulation: Shipping container designed for use as insulation with minimum R of 4.5 and 25/50 fire smoke rating.

2.5 HOSE KITS

A. General: Complete coil hook-ups for valve systems 3/4" to 2" consisting of threaded end connections, unions, full port ball valves, Y-strainers, automatic flow control valves, pressure/temperature test ports, air vents, drain valves and flexible hose connectors may be utilized in lieu of individually specified components. Coil hook-ups shall be manufactured by Bell and Gossett, Flow Design Inc., Griswold, Hays Fluid Controls, HCi, Nexus, Nibco, Oventrop Corporation, Red-White Valve Corp. or Victaulic. Coil hook-up kits shall be same size as piping runout to equipment not equipment connection size.

B. Hose kits shall be designed for minimum 400 psig working pressure, and operating temperatures from 33 to 211 deg F. Tag hose kits to equipment designations.

C. Hose: Minimum diameter, equal to pipe runout size not unit connection size.

D. Refer to Piping Connection details for required valves and components and their arrangement.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Refer to drawings for additional requirements for piping connections and details.

3.2 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 VALVE APPLICATIONS

A. Valves and installation shall suitable for indicated service with design pressure and temperature ratings as indicated in Part 1 “Performance Requirements” Article.

B. Valves to be compatible with associated piping systems utilizing screwed or flanged ends and utilizing transition fittings for piping connections as required. Valves may utilize pressure seal or grooved connections in piping specifications.

C. Provide stainless steel construction for steel valves when used on piping systems in corrosive environments. Refer to Division 23 Section "Hydronic Piping" for systems considered corrosive.

D. Shutoff Service: Ball valves

E. Drain Valves: Ball valves.

F. Provide memory stop for all balancing valves.

3.5 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Install shutoff valves at all equipment, at each branch take-off from mains and sub-mains, at the base of each riser serving multiple floors and at each automatic valve for servicing.

C. Install shut off valve upstream of each air vent to permit isolation of the air vent.

D. Compliance: In accord with approved submittals and manufacturer's written instructions.

E. Install valves in horizontal piping with stem at or above center of pipe.

F. Install valves in position to allow full stem movement.

G. Provide chained caps at all vent and drain manual valves unless vent or drain is piped to a drain.

END OF SECTION

SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following hangers and supports for HVAC system ductwork, piping and equipment:

1. Duct mounting pedestal
2. Roof pipe penetrations
3. Pipe hangers and supports.
4. Trapeze pipe hangers.
5. Metal framing systems.
6. Thermal-hanger shield inserts.
7. Fastener systems.

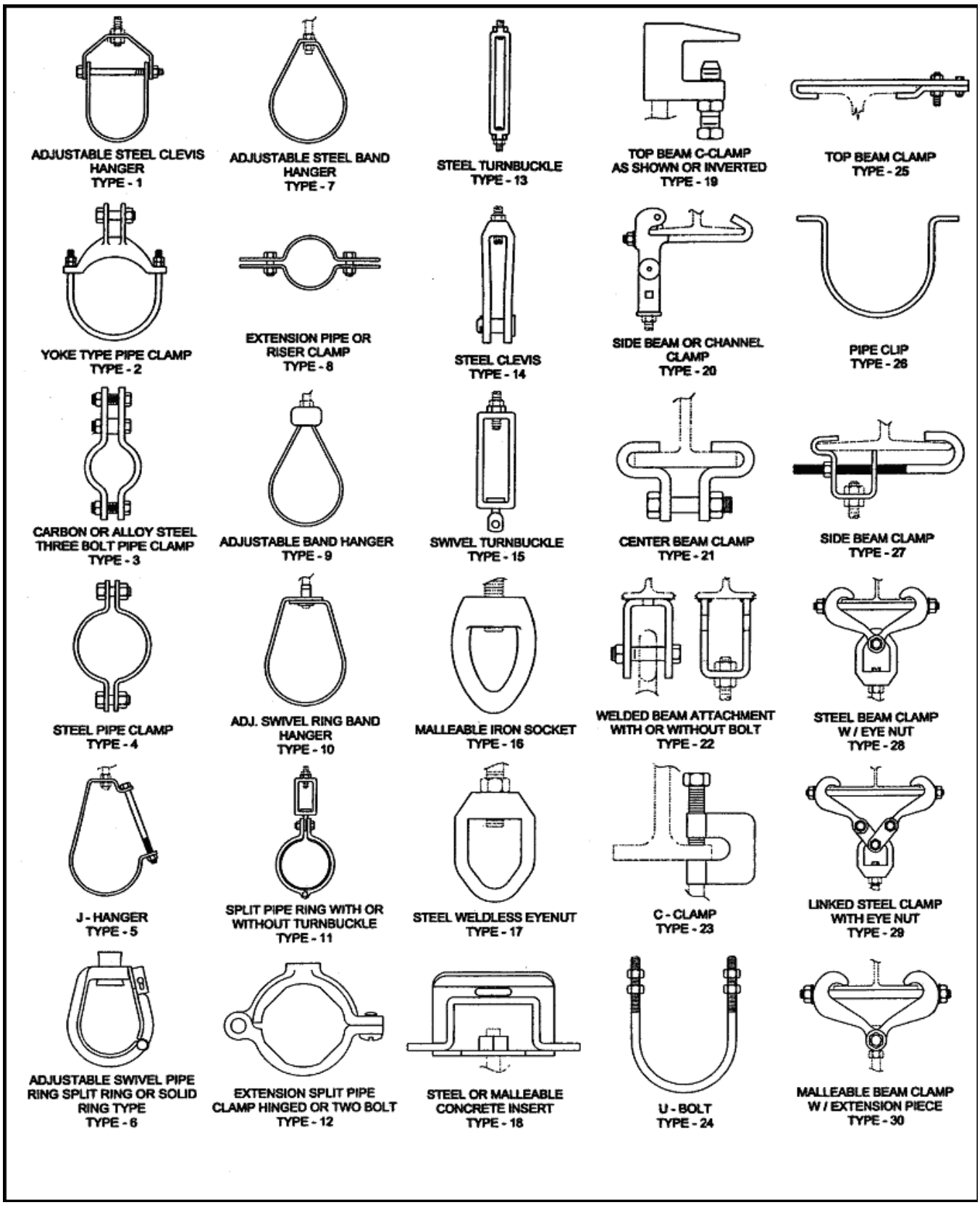
B. Related Sections include:

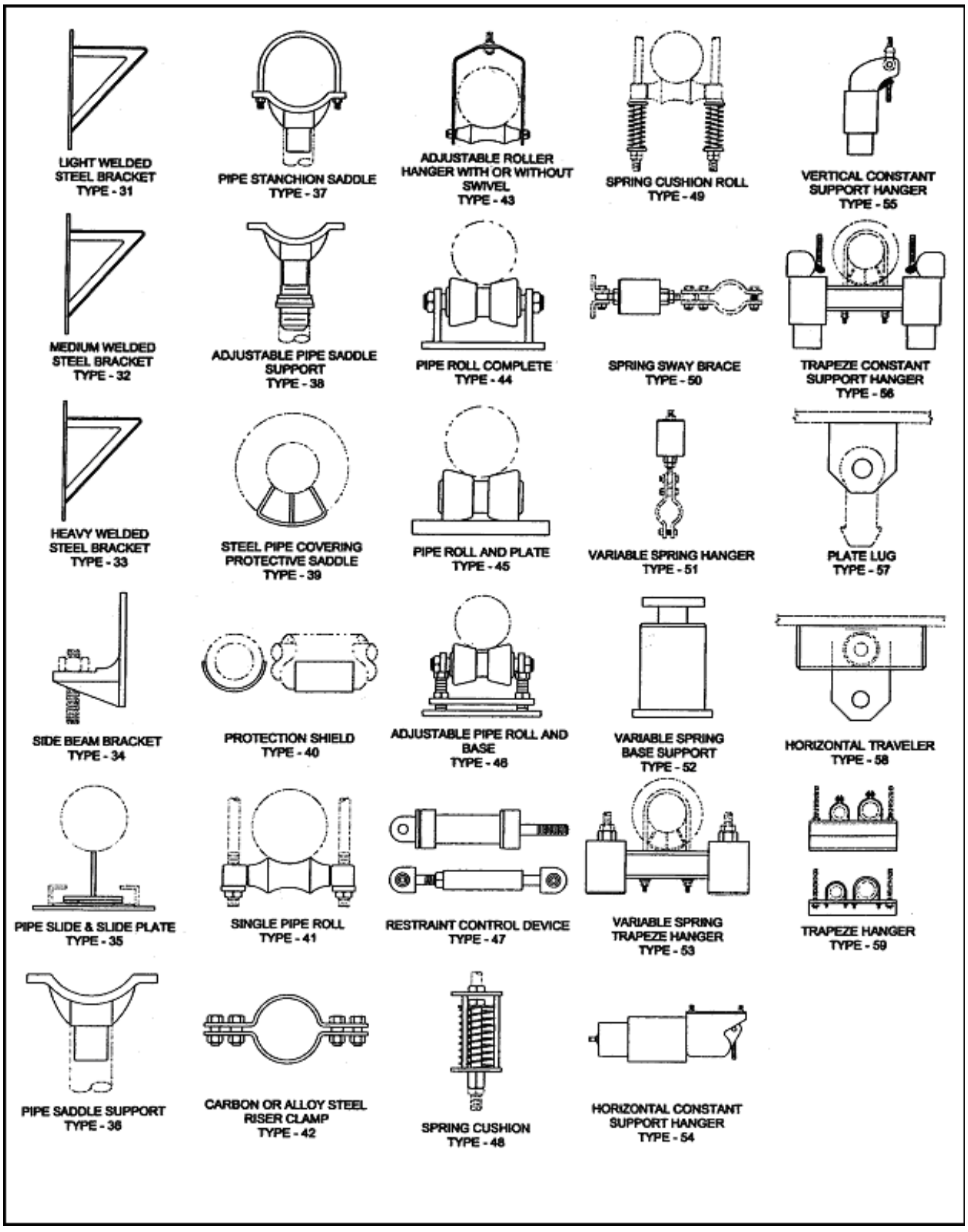
1. Division 23 Section “Vibration Controls for HVAC.”
2. Division 23 Section “Seismic Restraint for HVAC.”
3. Division 23 Section “Metal Ducts.”
4. Division 23 Section “Hydronic Piping”.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.

B. Description: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports", refer to the following figures when the “Type” hanger or support is indicated in Part 2 and 3 of this specification.


ADJUSTABLE STEEL CLEVIS HANGER TYPE - 1
ADJUSTABLE STEEL BAND HANGER TYPE - 7
STEEL TURNBUCKLE TYPE - 13
TOP BEAM C-CLAMP AS SHOWN OR INVERTED TYPE - 19
TOP BEAM CLAMP TYPE - 25
YOKE TYPE PIPE CLAMP TYPE - 2
EXTENSION PIPE OR RISER CLAMP TYPE - 8
STEEL CLEVIS TYPE - 14
SIDE BEAM OR CHANNEL CLAMP TYPE - 20
PIPE CLIP TYPE - 26
CARBON OR ALLOY STEEL THREE BOLT PIPE CLAMP TYPE - 3
ADJUSTABLE BAND HANGER TYPE - 9
SWIVEL TURNBUCKLE TYPE - 15
CENTER BEAM CLAMP TYPE - 21
SIDE BEAM CLAMP TYPE - 27
STEEL PIPE CLAMP TYPE - 4
ADJ. SWIVEL RING BAND HANGER TYPE - 10
MALLEABLE IRON SOCKET TYPE - 16
WELDED BEAM ATTACHMENT WITH OR WITHOUT BOLT TYPE - 22
STEEL BEAM CLAMP W / EYE NUT TYPE - 28
J - HANGER TYPE - 5
SPLIT PIPE RING WITH OR WITHOUT TURNBUCKLE TYPE - 11
STEEL WELDLESS EYENUT TYPE - 17
C - CLAMP TYPE - 23
LINKED STEEL CLAMP WITH EYE NUT TYPE - 29
ADJUSTABLE SWIVEL PIPE RING SPLIT RING OR SOLID RING TYPE TYPE - 6
EXTENSION SPLIT PIPE CLAMP HINGED OR TWO BOLT TYPE - 12
STEEL OR MALLEABLE CONCRETE INSERT TYPE - 18
U - BOLT TYPE - 24
MALLEABLE BEAM CLAMP W / EXTENSION PIECE TYPE - 30


LIGHT WELDED STEEL BRACKET TYPE - 31
PIPE STANCHION SADDLE TYPE - 37
ADJUSTABLE ROLLER HANGER WITH OR WITHOUT SWIVEL TYPE - 43
SPRING CUSHION ROLL TYPE - 49
VERTICAL CONSTANT SUPPORT HANGER TYPE - 55
MEDIUM WELDED STEEL BRACKET TYPE - 32
ADJUSTABLE PIPE SADDLE SUPPORT TYPE - 38
PIPE ROLL COMPLETE TYPE - 44
SPRING SWAY BRACE TYPE - 50
TRAPEZE CONSTANT SUPPORT HANGER TYPE - 56
HEAVY WELDED STEEL BRACKET TYPE - 33
STEEL PIPE COVERING PROTECTIVE SADDLE TYPE - 39
PIPE ROLL AND PLATE TYPE - 45
VARIABLE SPRING HANGER TYPE - 51
PLATE LUG TYPE - 57
SIDE BEAM BRACKET TYPE - 34
PROTECTION SHIELD TYPE - 40
ADJUSTABLE PIPE ROLL AND BASE TYPE - 46
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1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. General: Hangers and supports for HVAC piping and equipment shall withstand the effects of loads and stresses within limits and under conditions indicated according to ASCE 7. Design piping and equipment supports, including pipe stands, to support combined loads of supported systems, equipment and system contents.

C. Seismic: Equipment and associated mounting assemblies shall withstand the effects of seismic forces in accordance with project Seismic specifications.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of hanger and support indicated including:

1. Pipe, duct or equipment hanger: Type of lower attachment, hanger rod, upper attachment and building attachment.
2. Pipe, duct or equipment support, pedestal or stand: Type of attachment, support and building attachment.
3. Indicate materials, finishes, approvals and load ratings

B. Shop Drawings: Show fabrication and installation details coordinated with and sized for the associated piping, ductwork and equipment supported.

1.6 INFORMATIONAL SUBMITTALS

A. Wind compliance: Contractor’s certification of compliance with wind structural loading requirements of the Building Code, wind loads identified in “Performance Requirement” article. Coordinate with system or equipment being supported.

B. Seismic Qualification: Manufacturer’s certification of seismic qualification according to ASCE 7. Coordinate with system or equipment being supported.

C. Qualification Data: Submit proof of qualifications specified in Quality Assurance article.

1.7 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.2, "Structural Welding Code--Aluminum."
3. AWS D1.3, "Structural Welding Code--Sheet Steel."
4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
5. ASME Boiler and Pressure Vessel Code: Section IX.

B. Manufacturers Standardization Society: Hangers and supports in conformance with MSS including:

1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.8 DESIGN CRITERIA

A. Size, select and install hangers and supports in accordance with MSS, unless otherwise specified.

B. When this specification includes both insulation protection shields and thermal pipe shields. Contractor may use either device, coordinated with insulation specifications..

C. Contractor is responsible for proper placement of supporting devices to accommodate insulation and pitching of pipe as specified in other sections.

D. Provide vibration isolation and/or seismic restraints as specified in other sections.

E. Where piping can be conveniently grouped to allow the use of trapeze type supports, the supporting steel shall be by means of standard structural shapes or continuous insert channels.

F. For non-corrosive service, all upper attachments, hangers, supports, rods and other devices shall be of galvanized construction.

PART 2 - PRODUCTS

2.1 EQUIPMENT SUPPORTS

A. Provide all supporting steel, not indicated on the structural drawings, that is required for the installation of mechanical equipment, ductwork, piping and materials, including angles, channels, beams, etc., to suspend or floor support ductwork, piping tanks and equipment

2.2 DUCT MOUNTING PEDESTAL

A. Consisting of an equipment rail, “U” shaped support brackets, galvanized steel or stainless steel threaded rod and duct slide assembly. The pedestal shall suitable for bolting to floor slab or roof support.

2.3 ROOF PIPE PENETRATIONS

A. General: Roofing penetrations used shall be in compliance with project details and roofing manufacturer's requirements, methods and approved details.

B. Curb Type: Consisting of a EPDM protective rubber cap for single or multiple insulated and non-insulated pipes, stainless steel clamps, galvanized, stainless or aluminum curb cover and prefabricated insulated roof curb. Provide high temperature rubber cap as required to meet the application.

C. Portal Type: Consisting of a EPDM protective rubber cap for single or multiple insulated and non-insulated pipes, pipe stand supports, stainless steel clamps, plastic or aluminum portal base designed to seal to roofing membrane. Provide high temperature rubber cap as required to meet the application.

D. Hood Type: Consisting of a galvanized, stainless steel or aluminum heavy gauge metal hood and prefabricated insulated roof curb sized for number and size of pipes.

2.4 PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components with shields for insulated piping. Constructed of galvanized steel, stainless steel, copper coated, plastic coated or aluminum.

2.5 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts with shields for insulated piping. Constructed of galvanized steel, stainless steel, copper coated, plastic coated or aluminum.

2.6 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components with shields for insulated piping. Constructed of galvanized steel, stainless steel or aluminum.

2.7 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig-minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.8 FASTENER SYSTEMS (Upper attachment to existing structure/deck by Structural – see Structural drawings)

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated (stainless steel in corrosive environments), for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

C. Concrete Screw Anchors: Screw insert type high strength carbon steel zinc-plated for use in interior not corrosive environments for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used. Hilti Kwik – HUZ-EZ series or approved equal.

D. Internally Threaded Anchor for Installation into Metal Deck: Concrete anchor shall be carbon steel, cast-in type with single internal thread and a sinz/yellow chromate plating. Anchor shall have a protective sleeve, steel flange with pre-drilled additional fastening holes and placement spring for attachment to metal deck, anchor is to be secured by clamping the deck between the steel flange and the protective plastic sleeve. Anchor shall bear the diameter and the manufactrer name on hexagonal head..

E. Internally Threaded Anchor for Installation into formed wood concrete deck: Concrete anchor shall be carbon steel, cast-in type with single internal thread and a zinc/yellow chromate plating and contained by a plastic flange. Anchor shall have break-off nails for attachment to the surface of wood forms. Anchor will bear the diameter and manufacturer name on hexagonal head.

2.9 PIPE STANDS

A. General: Pipe stands to be factory or shop fabricated utilizing pipes or struts to support piping, ductwork or equipment at the roof level. Roofing penetrations used shall be in compliance with project details and roofing manufacturer’s requirements, methods and approved details.

B. Pipe Stands: Shop fabricated assemblies constructed of galvanized steel, stainless steel or aluminum designed by delegated contractor to support and tie down roof-mounted equipment, ductwork and piping. Stands bases to be secured to structure. Roof stands to pipe supports to either secure to structure or connect to roof curb or roof rail.

2.10 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT, GENERAL

A. Install and size pipe support, hanger rod, pipe stand and upper attachments suitable for indicated service with performance and design criteria as indicated in Part 1 “Performance Requirements” Article.

B. Select type pipe support, hanger rod, and upper attachment to accommodate piping axial movement due to thermal expansion or building movement as indicated in Part 1 “Performance Requirements” Article. For individual piping supports with fixed pipe support, small axial motion may be absorbed by swing of hanger rod up to the greater of a maximum of 4 degrees or manufacturer’s recommendations.

C. Materials

1. Use hangers and supports with galvanized, metallic coatings for normal service piping and equipment that will not have field-applied finish.
2. Use stainless-steel, aluminum or fiberglass hangers and supports for corrosive service.
3. Use vinyl ester resin fiberglass for “ozone” applications.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Plastic coated, plastic inserts or copper-plated hangers shall be provided for copper piping in direct contact with hangers.

F. Hangers and supports for piping connected in conjunction with rotating or reciprocating equipment shall be spring hangers and supports for a distance of 100-pipe diameters, or a

distance of three hangers away from rotating or reciprocating equipment whichever is greater. Isolators shall be as specified under Vibration Isolation.

G. For pipes, ducts and equipment supported above the roof, provide pipe stands or struts at lengths as required to maintain minimum height above the roof per the Building Code. Provide tie downs per the building code with equipment utilizing bolted or rigid clip tiedowns, unless retrained type vibration isolation is required by vibration isolation specifications. Include installation of additional tie down straps over equipment when required by the AHJ. Provide water proof seal at roof and wall penetration.

3.2 HANGER AND SUPPORT SCHEDULE

A. Horizontal-Piping Hangers: Unless otherwise indicated , install the following types:

1. Adjustable, Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated individual piping:

   a. All systems NPS 2and smaller.
   b. Ambient and cold systems (119 deg Fand below) NPS 2 1/2and above not subject to thermal and seismic movement.

2. Adjustable, Roller Hangers (MSS Type 43): For suspension of noninsulated or insulated individual piping:

   a. Hot systems (120deg F and above) NPS 2 1/2and above subject to thermal and seismic movement.
   b. All systems NPS 2 1/2and above subject to seismic movement.

3. Adjustable Trapeze Hangers (MSS Type 49): For suspension of noninsulated or insulated multiple horizontal piping.

   a. Trapeze support selected and sized for associated loads suitable for mounting each pipe with (MSS Type 24) standard U-Bolt pipe strap, strut mounted pipe guide or (MSS Type 41 or 44) pipe roller.
   b. Pipe strap (MSS Type 24) for all systems NPS 1 1/2and smaller.
   c. Pipe strap (MSS Type 24) for ambient and cold systems (119deg Fand below) NPS 2and above not subject to seismic movement.
   d. Pipe roller (MSS Type 41 or 44) for hot systems (120deg Fand above) NPS 2and above subject to thermal and seismic movement.
   e. Adjustable type pipe support for individual piping which requires a specific slope.

B. Horizontal-Piping Supports: Unless otherwise indicated , install the following types when supporting noninsulated or insulated pipe from below either in equipment rooms or at exterior locations:

1. Adjustable, Pipe Saddle Supports (MSS Type 37): For support for individual pipes, NPS 2 to NPS 8not subject to thermal movement, with all thread rod for height adjustment and U-bolt to retain pipe.

2. Pipe rails or Pipe Stands: For support of multiple horizontal piping.

   a. Rail or stand support selected and sized for associated loads suitable for mounting each pipe with (MSS Type 24) standard U-Bolt pipe strap, strut mounted pipe guide or (MSS Type 41 or 44) pipe roller.

   b. Pipe strap (MSS Type 24) for all systems NPS 1 1/2and smaller.

   c. Pipe strap (MSS Type 24) for ambient and cold systems (119deg Fand below) NPS 2and above not subject to seismic movement.

   d. Pipe roller (MSS Type 41 or 44) for hot systems (120deg F NPS 2and above subject to thermal and seismic movement.

   e. Adjustable type pipe support for individual piping which requires a specific slope.

C. Wall-Piping Supports: Unless otherwise indicated, install the following types when supporting noninsulated or insulated pipe from walls either in equipment rooms or at exterior locations:

1. Pipe Stands: For support of multiple horizontal piping either cantilever (MSS type 31, 32, 33) or racked vertically.

   a. Pipe stand support selected and sized for associated loads suitable for mounting each pipe with (MSS Type 24) standard U-Bolt pipe strap, strut mounted pipe guide or (MSS Type 41 or 44) pipe roller for horizontal cantilever pipe stand..

   b. Pipe strap (MSS Type 24) for all systems NPS 1 1/2and smaller.

   c. Pipe strap (MSS Type 24) for ambient and cold systems (119deg Fand below) NPS 2and above not subject to seismic movement.

   d. Pipe roller mounted on horizontal cantilever pipe stand (MSS Type 41 or 44) for hot systems (120deg Fand above) NPS 2and above subject to thermal and seismic movement.

   e. Adjustable type pipe support for individual piping which requires a specific slope.

D. Vertical-Piping Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

3. Piping larger than 4", of lengths exceeding 30 feet, shall be additionally supported on base elbows secured to the building structure, with flexible supporting hangers, provided at top of riser to allow for pipe expansion in accord with vibration controls specifications.

E. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types suitable for threaded hanger rod connections:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.

2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations suitable to accommodate piping axial movement.

3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments suitable for piping with little to no axial movement.

4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations suitable to accommodate piping axial movement where swivel action is required.

F. Building Attachments: Per Structural Drawings

3.3 HANGER AND SUPPORT INSTALLATION

A. Install supporting devices as shown on the drawings, as detailed, and according to manufacturer's installation instructions.

B. Secure equipment and mounting assemblies to structure with positive attachments in accordance project's seismic loading requirements.

C. Secure exterior equipment and mounting assemblies to structure with positive attachments in accordance with project's seismic and/or wind loading requirements.

D. Coordinate support of mechanical, plumbing, electrical, life support systems, and other trades. Piping, ductwork, conduit, etc. located in same area running parallel is to be supported on similar supports.

E. Roof Curb Supports installation: Position and attach equipment rails and curbs with structure as detailed. Provide field installed fiber cant strip, flash and counter flash roofing membrane.

1. Equipment curbs to support associated equipment.

2. Install roof curbs in accordance with manufacturer's instruction of equipment supported.

F. Pipe Roof Penetrations: Install as detailed on the drawings at points where pipes are penetrating roof. Size pipe roof penetrations to accommodate associated piping. Provide water proof seal and air seal at roof penetration. Contractor may submit alternate method for engineer's review.

G. Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

H. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.

1. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

I. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

J. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
3. Install concrete screw anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
4. Install anchors for metal decking and wood forms prior to the concrete pour according to the manufacturer's instructions.

K. Pipe Stand Installation:

1. Pipe Stands: Assemble stand components as detailed on the drawings complete with anchors for positive attachments from structure to support to supported equipment. Provide water proof seal at roof penetration.
2. Roof Curb or Rail Mounted Type: Assemble stand components as detailed on the drawings complete with anchors for positive attachments from structure to support to supported equipment.
3. Zero penetration pipe supports are acceptable for pipe sizes to NPS 2 1/2 and smaller.

L. Roof Duct Pedestal Installation: Roof Curb Type: Assemble pedestal components as detailed on the drawings and secure to roof curb or rail.

M. Equipment Support installation: Install roof or wall stands as detailed on the drawings complete with anchors for positive attachments from structure to support to supported equipment. .

N. Wall Pipe Penetration Installation: Install at points where pipes are penetrating exterior walls. Contractor may submit alternate method for engineer's review.

O. Install hangers and supports complete with necessary upper attachments, inserts, bolts, rods, nuts, washers, and other accessories.

P. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

Q. Support apparatus and material for all conditions of operation, including variations in installed and operating weight of equipment and piping.

R. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

S. Install lateral bracing with pipe hangers and supports to prevent swaying.

T. Install building attachments within concrete slabs or attach to structural steel or structural wood. Install additional attachments within 1 foot of elbows and at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

U. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

V. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

W. Insulated Piping: Comply with the following:

1. Risers: Attach riser clamps and spacers to piping.

   a. Attach riser clamp to piping and insulate pipe and clamp for chilled water systems and hot systems with service temperatures above 140 deg F.
   b. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.

2. Horizontal Piping: Install hangers and guides to piping.

a. Protective Shields: MSS SP-58, Type 40, shields on cold and hot piping. Shields shall span an arc of 180 degrees with length sufficient to prevent compression of insulation and associated loss of R-Value.
b. Protective Saddles: MSS SP-58, Type 39, saddles on hot piping systems and fill interior voids with insulation. Provide with protective shield spanning an arc of 180 degree with length sufficient to accommodate thermal and seismic movement of piping.
c. Thermal-hanger Shield Inserts (Insulated Pipe Supports): Insulated pipe supports with insulation same thickness as associated piping insulation may be used for cold and hot piping with protective shield spanning an arc of 180 degree with length sufficient to accommodate thermal and seismic movement of piping.

3. Shield Dimensions for Pipe: Length as required for insulation or expansion and not less than the following:

a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.

3.4 HANGER AND SUPPORT SPACING

A. Install and size hangers and supports for piping systems to meet maximum spacing requirements of the Building Code. Alternate longer spacing per MSS SP-69 are acceptable subject to approval of HCAI and subject to structural loading capacity of structure supporting the piping systems. Size hanger rods, trapeze supports, to support the associated loads.

B. Install hangers and pipe stands for steel piping with the following maximum spacing :

1. NPS 3/4: Maximum span, 7 feet.
2. NPS 1: Maximum span, 7 feet.
3. NPS 1-1/2: Maximum span, 9 feet.
4. NPS 2: Maximum span, 10 feet.
5. NPS 2-1/2: Maximum span, 11 feet.

C. Install hangers and pipe stands for drawn-temper copper piping with the following maximum spacing :

1. NPS 3/4: Maximum span, 5 feet.
2. NPS 1: Maximum span, 6 feet.
3. NPS 1-1/2 and NPS 2 Maximum span, 8 feet.
4. NPS 2-1/2: Maximum span, 9 feet.

D. Multiple Pipes of Various Sizes: When supported together on a common trapeze, rail or pipe stand, space for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.

E. Support vertical pipe risers less than 30 feet at roof, at each floor, and at additional intervals as required to limit loading on building structure.

3.5 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.6 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.7 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1 inch.

3.8 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 23 05 49 - SEISMIC RESTRAINT FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including general and supplementary conditions and Division 01 specifications, apply to this section.

1.2 SUMMARY

A. Related Requirements:

1. Division 23 Section “Hangers and Supports for HVAC Piping and Equipment” for commonly used HVAC supports and installation requirements.
2. Division 23 Section “Vibration Controls for HVAC” for restrained isolation devices.

1.3 DEFINITIONS

A. ASCE: American Society of Civil Engineers.

B. CBC: California Building Code.

C. Life Safety \ Emergency Systems:

1. All systems involved with fire protection, including sprinkler piping, fire pumps, jockey pumps, fire pump control panels, service water supply piping, water tanks, fire dampers and smoke exhaust.
2. All systems involved with production and distribution, of and utilization equipment connected to, emergency power supply.
3. All medical and life support systems.
4. Fresh air and relief systems on emergency smoke control sequence, including air handlers, conduit, duct, dampers, fans, etc.

D. HCAI: Dept. of Healthcare Access and Information for the State of California.

1.4 PERFORMANCE REQUIREMENTS

A. Equipment: Select support, attachment, and restraint details complying with requirements of CBC and ASCE 7 for equipment from one of the following HCAI Pre-Approvals.

B. Use seismic design values shown on structural drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Delegated-Design Submittal: For seismic restraint details governed by performance requirements, include analysis data signed and sealed by a professional engineer responsible for their preparation who is qualified for such work in the place of the project.

1. Design Calculations: Calculate loading due to equipment weight, operation, and seismic forces required to select seismic restraints.

a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors.

2. Include materials and dimensions and identify hardware, including attachment and anchorage devices, for equipment and for manufactured and field fabricated supports.
3. Seismic Restraint Details:

a. Design Analysis: Support selection and arrangement of seismic restraints.
b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Identify components, Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices, where applicable.
c. Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

B. Coordination Drawings: Show proposed locations of supports and restraints for distribution system components.

1. Show coordination of seismic bracing for HVAC & Piping components with other systems and equipment in the vicinity, including other supports and seismic restraints.
2. Include details selected from HCAI Pre-Approvals, and reference proposed locations to specific details selected.

1.6 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel".

C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage pre-approval OPA number from HCAI showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent

testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a State of California licensed structural engineer.

PART 2 - PRODUCTS

2.1 SEISMIC-RESTRAINT DEVICES

A. Basis-of-Design Product: Subject to compliance with requirements, provide products of Mason Industries or a comparable product by one of the following:

1. Cooper B-Line, Inc.; a division of Cooper Industries.
2. Hilti Inc.
3. Loos & Co.; Seismic Earthquake Division.
4. Mason Industries.
5. ISAT.
6. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components:

1. Components used in HCAI Pre-Approval details: Use products according to HCAI Pre-Approval details selected for this project.

2.2 FACTORY FINISHES

A. Finish: Manufacturer's standard paint or galvanized.

1. All hardware shall be galvanized. Hot-dip galvanized metal components for exterior use.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive seismic restraint devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing in of reinforcement and cast-in-place anchors to verify actual location before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATION

A. Multiple pipe supports: Secure piping to trapeze members with clamps according to HCAI Pre-Approval details.

B. Duct supports : Secure duct to trapeze members with method approved for application according to HCAI Pre-Approval details.

3.3 SEISMIC RESTRAINT DEVICE INSTALLATION

A. Install seismic restraint devices according to HCAI Pre-Approval details.

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections: Test and inspect to meet regulatory requirements.

END OF SECTION

SECTION 23 05 50 – VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes items for structural vibration isolation and includes the following:

1. Mounts.
2. Bases.
3. Hangers.
4. Restraints.
5. Anchors and guides.
6. Flexible pipe connections.

B. Related Sections include the following:

1. Division 23 Section "Seismic Restraint For HVAC" for requirements necessary for compliance with seismic criteria

1.3 ACTION SUBMITTALS

A. Product Data: Provide schedule and product data of isolation devices related to the equipment served. Schedule and data shall indicate isolation materials, isolator heights both free and operating, isolator dimensions, deflections, and isolation efficiency based on lowest operating speed.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification: Manufacturer’s certification of seismic qualification according to ASCE 7. Submit ASCE 7 special seismic certification as required. Include method used to determine compliance with requirements.

1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Products and methods of fabrication, subject to compliance with requirements, provide products by one of the following:

1. Mason Industries
2. Kinetics Noise Control
3. Korfund Company
4. Amber-Booth Company
5. Victaulic

2.2 MATERIALS

A. All isolation devices shall be designed for the equipment with which they will be used. Materials used shall retain their isolation characteristics for the life of the equipment served. All elastomeric materials shall be industrial grade neoprene. Isolation devices subject to weather shall have hot dipped galvanized finish.

2.3 TYPE 1 MOUNTS – (Neoprene Mount)

A. Mason type ND or rails type RND, double deflection neoprene mounts with cast-in metal inserts for bolting to equipment, and shall have a minimum static deflection of 0.35".

2.4 TYPE 2 MOUNTS – (Neoprene Pad)

A. Mason type W pads shall be bridge bearing neoprene, ¾" thick minimum. Pads shall be oil resistant.

B. Both surfaces shall be rib molded for skid resistance. On equipment such as small vent sets and close coupled pumps, steel rails shall be used above the mountings to compensate for the overhang.

2.5 TYPE 3 MOUNTS – (Spring Mount)

A. Mason type SLF, combination spring and neoprene with rib molded base. Spring type isolators shall be free standing and laterally stable without any housing, and complete with 1/2" neoprene acoustical friction pads between the baseplate and the support.

B. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load.

2.6 TYPE 4 MOUNTS – (Restrained Spring Mount)

A. Mason type SLR, combination spring and neoprene with rib molded base similar to type 2 above, but shall have a housing that includes vertical limit stops to prevent springs extension when weight is removed.

B. The installed and operating heights shall be the same. A minimum clearance of 1/2" shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Limit stops shall be out of contact during normal operation.

2.7 TYPE 5 HANGERS – (Spring)

A. Mason type 30N, vibration hangers with a steel spring and 0.3" deflection neoprene element in series. The neoprene element shall be molded with a rod isolation bushing that passes through the hanger box. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 degrees arc before contacting the hole and short circuiting the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.

2.8 TYPE 6 HANGERS – (Pre-compressed Spring)

A. Mason type PC30N, vibration hangers similar to type 4, but precompressed to the rated deflection so as to keep the piping or equipment at a fixed elevation during installation. Design hangers with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load.

2.9 FLEXIBLE PIPING CONNECTIONS

A. Provide flexible connections for all piping to equipment mounted on vibration isolators and all piping connected to rotating or reciprocating equipment.

B. Flexible connection shall be suitable for pressure, temperature and fluid involved.

C. Minimum line length of flexible hose shall be 12" or length required to absorb 3/4" lateral movement, whichever is longer.

D. Piping connected to a coil which is in an assembly mounted on vibration isolators is to have flexible piping connections and piping vibration hangers as specified below. Piping connected to a coil which is in an assembly where the fan is separately isolated by means of vibration isolators and duct flexible connections does not require flexible piping connectors or piping vibration hangers.

E. Do not provide flexible piping connectors for the following systems:

1. Refrigerant piping
2. Gas piping

F. Engine Exhaust:

1. Provide Bellows joint similar to Selkirk Metalbestos BJ.

2.10 PERFORMANCE

A. Select all vibration isolation devices to provide minimum 95% isolation efficiency or based on the minimum static deflection and mounting criteria listed below, whichever is greater:

Equipment Type	**Floor Span**							
	On Grade		**20-Feet**		**30-Feet**		**40-Feet**	
	Type	Min. Stat. Defl. In.	Type	Min. Stat. Defl. In.	Type	Min. Stat. Defl. In.	Type	Min. Stat. Defl. In.
Air-Cooled Condensing Units	2	0.35	4	0.75	4	1.5	4	2.5
Fan Coil Units up to 1200 CFM	-	-	1	0.35	1	0.35	1	0.35
Utility Sets								
Roof Mounted	Use type 4-5 mount with deflection from blower minimum deflection 1 ½"							
Piping connected to rotating or reciprocating equipment	Use flexible piping connections, and type 5 or 6 hangers for a distance of 50 feet away from the equipment.							

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with mounting and anchoring requirements for seismic installations.
B. Coordinate the selection of devices with the isolator and equipment manufacturer.
C. Isolate all motor driven mechanical equipment, unless otherwise noted, from the building structure, and from the systems which they serve, to prevent equipment vibrations from being transmitted to the structure.
D. Consider equipment weight distribution to provide uniform deflections.
E. For equipment with variable speed capability, select vibration isolation devices based on the lowest speed.
F. Install vibration isolation devices as specified, as shown on the drawings and according to the manufacturer's instructions.
G. In no case shall the installation short circuit the isolation device. Flexible piping connections are to be installed on the equipment side of shut-off valves.

END OF SECTION

SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Pipe and equipment painting.
4. Valve tags.

1.3 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black. Red shall be used if the equipment is on emergency power.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 1-1/2 inch.
6. Minimum Letter Size: 1/2 inch Include secondary lettering two-thirds to three-fourths the size of principal lettering.

7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
9. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper, tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

B. Ceiling Grid Labels for concealed equipment and valves:

1. Coordinate label style (e.g. Kroy/P-Touch tape, color coded dots, etc.) with architect and owner.

2.2 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.3 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

C. In addition to installing labels on each major item of mechanical equipment, adhesive labels shall be located on ceiling grids directly below equipment concealed in ceilings such as reheat coils, fan coil units, air handling units, VAV boxes, fire and fire/smoke dampers and other similar equipment that requires access for service. Labels shall also be installed for all branch shutoff valves.

3.3 PIPING IDENTIFICATION

A. Piping Color-Coding: Painting of piping is specified in Division 09. In the absence of specific requirements to the contrary in Division 9, all exposed equipment, piping, hangers, etc., shall be painted by the Contractor. Confirm with Owner the color scheme prior to commencing with painting. Unless otherwise directed, each system shall be painted according to the following schedule:

SYSTEM	COLOR
Steam	Yellow
Condensate (Steam)	Orange
Hot Water Supply & Return	Orange

B. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 20 feet along each run. Reduce intervals to 10 feet in areas of congested piping and equipment
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels
8. At least once in each room.

C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

END OF SECTION

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Refer to Division 01 General Requirements – Specification Section 01 91 13 "General Commissioning Requirements" for the Testing, Adjusting, and Balancing (TAB) requirements to support Commissioning.

1.2 SUMMARY

A. This Section includes TAB to produce design objectives for all air and water systems including, but not limited to the following:

1. Air Systems.
2. Hydronic Systems.
3. Existing systems TAB
4. Verifying that automatic control devices are functioning properly.
5. Reporting results of activities and procedures specified in this Section.

B. Related Sections include:

1. Division 01 Section “General Requirements”.

2. Specification Section 01 91 13 "General Commissioning Requirements" for the Testing, Adjusting, and Balancing (TAB) requirements to support Commissioning.

1.3 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.

C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.

D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

E. NC: Noise Criteria.

F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

G. RC: Room Criteria.

H. Report Forms: Test data sheets for recording test data in logical order.

I. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

J. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

K. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

L. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

M. TAB: Testing, adjusting, and balancing.

N. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

O. Test: A procedure to determine quantitative performance of systems or equipment.

P. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

Q. VFD: Variable Frequency Motor Controllers

1.4 INFORMATIONAL SUBMITTALS

A. Certified TAB reports.

1.5 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by AABC or NEBB.

1. The supervisor directly in charge of this testing shall have a TAB certificate and shall have not less than two years of experience in TAB work.

B. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:

a. Submittal distribution requirements.
b. The Contract Documents examination report.
c. TAB plan.
d. Work schedule and Project-site access requirements.
e. Coordination and cooperation of trades and subcontractors.
f. Coordination of documentation and communication flow.
g. Schedule for submission of 1st Draft of TAB report.

C. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems." or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

E. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.

1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

G. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, "Air Balancing."

H. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, "System Balancing."

1.6 PROJECT CONDITIONS

A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Phased TAB: The project requires startup and initial checkout to be executed in phases. This phasing will be planned and scheduled in a coordination meeting by the construction team, led by the TAB agency.

C. Renovation of Existing Systems: Provide pre-demolition test report for existing systems to be renovated prior to demolition work and submit report prior to new construction.

1. Provide test data of renovated area to document existing capacity of systems to be renovated. The test shall establish existing water and air flows to sub-mains, branches and runouts inside the renovated area.
2. Where a portion of a system is not included within the Scope of Work boundary on the drawings, testing of the entire existing affected systems are required prior to construction. The first test shall establish existing water and air flows to sub-mains, branches and run-outs to areas which are not scheduled for renovation. The final test shall reset flows of water and air to sub-mains, branches and run-outs outside renovated area to the recorded values from the first test.
3. Include total capacity test of any scheduled existing equipment. Include flow test results of first and final balancing of existing systems in final report.
4. Follow work sequence as defined on drawings for TAB work.

1.7 DEFICIENCIES

A. Any deficiency in the installation or performance of a system or component observed by the TAB agency shall be brought to the attention of the appropriate responsible Contractor or person.

B. The work necessary to correct items on the deficiency list shall be performed and verified by the affected contractor or sub-contractor before the TAB agency returns to retest.

C. The TAB agency shall return to the site to readjust systems that do not test within specified requirements.

1.8 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

D. Coordinate schedule of on-site testing efforts and TAB report submission with the Contractor and/or the Commissioning Authority (CxA). It is intended that the TAB report will be submitted prior to on-site Commissioning witness testing.

1.9 WARRANTY

A. Special Guarantee: Provide a guarantee on national certifying agency forms stating that the national certifying agency will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

1. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine Project Record Documents described in Division 01 Section "Project Record Documents."

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6 and/or ASHRAE “Fundamentals Handbook” Duct Design Chapter. Compare this data with the design data and installed conditions.

F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

K. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible, and their controls are connected and functioning.

L. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.

M. Examine strainers for clean screens and proper perforations.

N. Examine two-way valves for proper installation for their intended function of diverting or mixing fluid flows.

O. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

P. Examine system pumps to ensure absence of entrained air in the suction piping.

Q. Examine equipment for installation and for properly operating safety interlocks and controls.

R. Examine automatic temperature system components to verify the following:

1. Dampers, valves, and other controlled devices are operated by the intended controller.
2. Dampers and valves are in the position indicated by the controller.
3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
6. Sensors are located to sense only the intended conditions.
7. Sequence of operation for control modes is according to the Contract Documents.
8. Controller set points are set at indicated values.
9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to indicated values.

S. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Airside:

a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
b. Duct systems are complete with terminals installed.
c. Volume, smoke, and fire dampers are open and functional.
d. Clean filters are installed.
e. Fans are operating, free of vibration, and rotating in correct direction.
f. VFD startup is complete, and safeties are verified.
g. Automatic temperature-control systems are operational.
h. Equipment and duct access doors are securely closed.
i. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided
j. Windows and doors are installed.
k. Suitable access to balancing devices and equipment is provided.

2. Hydronics:

a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
b. Hydronic systems are filled, clean, and free of air.
c. Piping is complete with terminals installed.
d. Systems are flushed, filled, and air purged.
e. Control valves are functioning in accordance with the sequence of operation.
f. Shutoff and balance valves have been verified to be 100 percent open.
g. Isolating and balancing valves are open and control valves are operational.
h. VFD startup is complete, and safeties are verified.
i. Suitable access to balancing devices and equipment is provided.

3.3 TAB CONSTRUCTION ADMINSTRATION SERVICES

A. Project Site Observations: During construction, the TAB agency shall observe the installation of pipe systems, sheet metal work, temperature controls, and other component parts of the HVAC systems. Provide a minimum of two site observations when HVAC systems are approximately 50% and 80% complete and issue Field Reports indicating observations and noted deficiencies.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in the TAB firm's national certifying agency: AABC or NEBB; and this section.

1. Comply with requirements in ASHRAE 62.1, "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

D. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air-handling unit components.

K. Check for proper sealing of air duct system.

L. Fans with Adjustable Speed Drives should be provided with the largest non-overloading sheaves available to match the “full speed” of the motor in Bypass or Hand mode of the Drive.

M. For constant speed fans, after the system is balanced, fixed pitch sheaves shall replace the variable pitch sheaves for all motors using multiple belt drives.

N. Outside Air. Test and adjust the outside air on applicable equipment. Outside air damper percent open shall be documented and provided to BAS contractor.

O. Fan Static Pressure Profile. Provide a diagram of each fan and air handling unit showing the static pressure profile through each pressure drop device (coil, damper, fan, coil, dampers, etc)

P. Energy Efficiency Balancing Approach: At least one run-out volume damper shall be full open in efforts to provide an energy efficient balanced system.

Q. Room Airflow Tolerance. While the air outlet tolerances are +/- 5%, the Room total air balance shall also be within 5% of the scheduled room air flow.

R. Provide duct smoke detector air differential pressure test for each duct detector in accordance with the manufacturer’s instructions to insure detectors have been properly installed. Contractor shall correct any deficient installation and TAB agency shall retest.

3.6 PROCEDURES FOR MULTI-ZONE CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure fan static pressures to determine actual static pressure as follows:

a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
b. Measure static pressure directly at the fan outlet or through the flexible connection.
c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and air-treating equipment.

a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
5. Make required adjustments to pulley/sheave sizes, motor sizes, and electrical connections to accommodate fan-speed changes. Replace pulley/sheaves to provide the required fan rpm.
6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower (kW).

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.

a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

E. CAV System Static Pressure Control:

1. After balancing the terminal units of the system, simulate the dirty filter pressure drop conditions.
2. Work with the controls contractor to set the fan pressure control tracking setpoint to maintain the specified flow. Record in the TAB report the static pressure requirement at the static pressure sensor. Optimize the balancing so the static pressure setpoint is as low as possible to achieve airflow at the furthest diffuser with simulated dirty filter pressure drop.
3. Record the fan adjustable speed drive speeds at both the clean and dirty filter conditions. Note that the fan shall be sheaved so the adjustable speed drive should be less than 100% at dirty filter conditions.

F. Economizer Systems:

1. Balance the supply air side according to CAV procedures using minimum outdoor air volumes. Record the balanced system return duct static pressure at the control system sensor.
2. For CAV systems the design intent is for the exhaust/return fan speed to modulate to maintain the return duct static pressure setpoint.
3. The control contractor should turn the AHU system to full economizer mode, using 100% outside air. During this mode the exhaust/return fan sheaves and fan adjustable speed drive should be set up so the adjustable speed drive is no more than 90%. This will leave 10% spare capacity for future adjustments.
4. Part Load Performance: Record duct static pressures and fan speeds for outdoor air volumes of 100%, 75%, 50%, and 25%

G. Set Constant Volume Air Terminal to Indicated Airflow

3.7 PROCEDURES FOR EXISTING DUAL-DUCT SYSTEMS

A. Set mixing boxes for constant discharge airflow.

B. Adjust each mixing box to indicated airflow.

3.8 GENERAL PROCEDURES FOR SYSTEM BALANCING WITH AIR FILTERS

A. For supply or exhaust systems with filters, the systems shall be balanced with clean filters, then re-tested with simulated dirty filter pressure drop conditions.

B. Dirty Filter Simulation: Use a filter area blank off plate made of cardboard or plastic to simulate the dirty filter pressure drop.

C. Document main traversed air flows with both clean and dirty filter pressure drops.

D. Coordinate with Contractor to replace the construction filters with new filters prior to TAB.

E. If not provided in the Contract Documents, use the following values for dirty filter pressure drops.

Filter	Assumed Clean DP	Dirty DP
30% Pre (flat)	0.3”	0.6”
30% Pre (angled)	0.3”	0.6”
>60%	0.5”	1.0”
>90%	0.75”	1.5”
99%	0.75”	1.5”

3.9 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check makeup-water-station pressure gage for adequate pressure for highest vent.
3. Check flow-control valves for specified sequence of operation and set at indicated flow.
4. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
5. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.10 PROCEDURES FOR HYDRONIC SYSTEMS

A. Balancing: Calibrated balancing valves may be utilized for constant volume pumping systems,

1. Set calibrated balancing valves, if installed, at calculated pre-settings and test and adjust to achieve design.
2. Systems installed with automatic flow control valves do not require terminal level hydronic balancing. For automatic flow control valves (flow limiting valves), measure and verify that the differential pressure is in the proper range for all coils.
3. Systems installed with pressure independent control valves do not require terminal level hydronic system balancing. For pressure independent control valves flow regulator type, measure and verify that the differential pressure is in the proper range for all coils. For electronic pressure independent control valves, verify flow is in the proper range for all coils. Any individual adjustments for the pressure independent valve assembly (valve and actuator combination) for field conditions shall be performed using the pressure independent control valve manufacturer's requirements.

B. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
3. Record settings and mark balancing devices.

3.11 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two-way control valves.

B. For systems with flow diversity:

1. Adjust flow-measuring devices installed at terminals for each space to design water flows.

a. Measure flow at terminals.
b. Adjust each terminal to design flow.
c. Re-measure each terminal after it is adjusted.
d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
e. Perform temperature tests after flows have been balanced.

2. For systems with pressure-independent valves at terminals:

a. Measure differential pressure, and verify that it is within manufacturer's specified range.
b. Perform temperature tests after flows have been verified.

3. For systems without pressure-independent valves or flow-measuring devices at terminals:

   a. Measure and balance coils by either coil pressure drop or temperature method.
   b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

4. Mark final settings and verify that memory stops have been set.

3.12 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer, model, and serial numbers.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by VFD's: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass (if applicable) for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.13 PROCEDURES FOR HEAT-TRANSFER COILS

A. Water Coils: Measure the following data for each coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Refrigerant Coils: Measure the following data for each coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

C. Manual Balancing Valves (pressure dependent valves): Measure the following data for each coil or device:

1. Valve type
2. Location
3. Valve differential pressure reading
4. Coil pressure drop
5. GPM

D. Pressure Independent Flow Control Valves (flow limiting valves): Measure the following data for each valve:

1. Valve type
2. Location
3. Valve differential pressure reading
4. Factory differential pressure control range, and verify the valve is within pressure tolerance.

E. Pressure Independent Control Valves: Measure the following data for each valve:

1. Valve type: mechanical pressure regulator or electronic flow meter with integral control valve.
2. Location
3. Regulator type: Valve differential pressure reading, factory differential pressure control range and verify the valve pressure regulator is within pressure tolerance.
4. Electronic type: Factory valve flow setting.

3.14 PROCEDURES FOR TEMPERATURE MEASUREMENTS

A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.

B. For Air Handling Units: Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied. This can be accomplished thru the Building Automation System.

C. Measure outside-air, wet- and dry-bulb temperatures.

3.15 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused to document existing performance.

B. Document flows of existing systems prior to demolition and submit testing report to document system capacity supports renovation design and will maintain existing air flows to existing non renovated areas upon final test and balance.

1. Measure and record the operating speed, airflow, and static pressure of each fan and air handler.
2. Measure and record air flows for the portion of the duct system within the renovated area.
3. Measure and record air flows for the portion of the duct system outside the renovated area. This data is to be used upon renovation completion to reset existing flows to that recorded prior to demolition.
4. Measure motor voltage and amperage. Compare the values to motor nameplate information.
5. Check the refrigerant charge.
6. Check the condition of filters.
7. Check the condition of coils.
8. Check the operation of the drain pan and condensate drain trap.
9. Check bearings and other lubricated parts for proper lubrication.
10. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

C. Before performing final testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished.

1. New filters are installed.
2. Coils are clean and fins combed.
3. Drain pans are clean.
4. Fans are clean.
5. Bearings and other parts are properly lubricated.
6. Deficiencies noted in the preconstruction report are corrected.

D. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows and determine the new fan, speed, filter, and coil face velocity.
2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the airflow and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated airflow and water flow rates. If 5 percent or less, equipment adjustments are not required.
4. Air balance each air outlet.

3.16 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 percent to minus 5 percent. This includes duct distribution loss. For systems where minimum air change or other minimum airflows are required, tolerance shall be 0 to plus 5%.
2. Air Outlets and Inlets: Plus 5 percent to minus 5 percent, as long as the overall room is balanced properly and room minimum code required total air changes per hour are maintained.
3. Smoke Control Supply and Exhaust Fans and other Equipment with fans and Air Outlets and Inlets associated with smoke control systems: 0 percent to plus 5 percent.
4. Heating-Water Flow Rate: Plus 5 percent to minus 5 percent.
5. Cooling-Water Flow Rate: Plus 5 percent to minus 5 percent.
6. Generation Equipment (chillers, boilers, etc) should be balanced as close as possible to the accuracy of the measuring equipment.
7. Fume Hood and Biosafety Cabinet airflows should be balanced as close as possible to the accuracy of the measuring equipment.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.17 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.18 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data

B. Final Report Contents: In addition to certified field report data, include the following:

1. Fan curves.
2. Manufacturers' test data.

3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of TAB firm.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB firm who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer, type size, and fittings.
14. Notes to explain why certain final data in the body of reports varies from indicated values.
15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outside-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils if applicable.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Settings for supply-air, static-pressure controller.
    g. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outside, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.

6. Balancing stations.
7. Position of balancing devices.

E. General Report requirements: Include the following in reports for all equipment for comparison for recorded values:

1. Current BAS sensor readings for Outdoor airflow, CHW flowmeter, static pressure sensors, etc.

F. Air-Handling Unit, Fan Coil Unit and Blower Coil Unit Test Reports: For units with coils, include the following:

1. Unit Data: Include the following:

a. Unit identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches, and bore.
i. Sheave dimensions, center-to-center, and amount of adjustments in inches.
j. Number of belts, make, and size.
k. Number of filters, type, and size.

2. Motor Data:

a. Make and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Sheave dimensions, center-to-center, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Filter static-pressure differential in inches wg.
f. Preheat coil static-pressure differential in inches wg.
g. Cooling coil static-pressure differential in inches wg.
h. Heating coil static-pressure differential in inches wg.
i. For Multizone VAV AHU’s: Maximum and Minimum static pressure setpoints inches wg.

j. For Single zone VAV AHU's: VFD speeds corresponding to design maximum, minimum and heating airflows.
k. Outside airflow in cfm.
l. Return airflow in cfm.
m. Outside-air damper position.
n. Return-air damper position.

G. Apparatus-Coil Test Reports:

1. Coil Data:

a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch o.c.
f. Make and model number.
g. Face area in sq. ft..
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outside-air, wet- and dry-bulb temperatures in deg F.
e. Return-air, wet- and dry-bulb temperatures in deg F.
f. Entering-air, wet- and dry-bulb temperatures in deg F.
g. Leaving-air, wet- and dry-bulb temperatures in deg F.
h. Water flow rate in gpm.
i. Water pressure differential in feet of head or psig.
j. Entering-water temperature in deg F.
k. Leaving-water temperature in deg F.
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig.
n. Refrigerant suction temperature in deg F.
o. Inlet steam pressure in psig.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.

e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Sheave dimensions, center-to-center, and amount of adjustments in inches.

2. Motor Data:

a. Make and frame type and size.
b. Horsepower (KW) and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
g. Number of belts, make, and size.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft..
g. Indicated airflow rate in cfm.
h. Indicated velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.

J. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Test apparatus used.
d. Area served.
e. Air-terminal-device make.

f. Air-terminal-device number from system diagram.
g. Air-terminal-device type and model number.
h. Air-terminal-device size.
i. Air-terminal-device effective area in sq. ft..

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Air velocity in fpm.
c. Preliminary airflow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final airflow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Room or riser served.
d. Coil make and size.
e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Entering-water temperature in deg F.
c. Leaving-water temperature in deg F.
d. Water pressure drop in feet of head or psig.
e. Entering-air temperature in deg F.
f. Leaving-air temperature in deg F.

L. Compressor and Condenser Reports: For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units, or water-cooled condensing units, include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Unit make and model number.
d. Compressor make.
e. Compressor model and serial numbers.
f. Refrigerant weight in lb.
g. Low ambient temperature cutoff in deg F.

2. Test Data (Indicated and Actual Values):

a. Inlet-duct static pressure in inches wg.
b. Outlet-duct static pressure in inches wg.
c. Entering-air, dry-bulb temperature in deg F.
d. Leaving-air, dry-bulb temperature in deg F.
e. Condenser entering-water temperature in deg F.
f. Condenser leaving-water temperature in deg F.
g. Condenser-water temperature differential in deg F.
h. Condenser entering-water pressure in feet of head or psig.
i. Condenser leaving-water pressure in feet of head or psig.
j. Condenser-water pressure differential in feet of head or psig.
k. Control settings.
l. Unloader set points.
m. Low-pressure-cutout set point in psig.
n. High-pressure-cutout set point in psig.
o. Suction pressure in psig.
p. Suction temperature in deg F.
q. Condenser refrigerant pressure in psig.
r. Condenser refrigerant temperature in deg F.
s. Oil pressure in psig.
t. Oil temperature in deg F.
u. Voltage at each connection.
v. Amperage for each phase.
w. Kilowatt input.
x. Crankcase heater kilowatt.
y. Number of fans.
z. Condenser fan rpm.
aa. Condenser fan airflow rate in cfm.
bb. Condenser fan motor make, frame size, rpm, and horsepower.
cc. Condenser fan motor voltage at each connection.
dd. Condenser fan motor amperage for each phase.

3.19 GAUGE AND SENSOR ACCURACY VALIDATION

A. The accuracy of the project's installed gauges, thermometers and sensors shall be validated by the TAB Contractor. The TAB Contractor shall use calibrated gauges and thermometers and compare the values against the contractor installed gauges, thermometers and sensors.

1. Pressure gauges and BAS sensors – Water Systems

a. The installed pressure gauges shall be within 2 psi or 5% of the TAB contractors calibrated gauge at the normal system operating pressure.
b. TAB shall notify the Mechanical Contractor of any gauge deficiency, for the gauge to be recalibrated or replaced.
c. Replaced gauges shall be verified for accuracy by TAB.

2. Thermometers and BAS sensors – Water Systems

   a. The installed thermometers and sensors shall be within the following tolerances of the TAB contractor's calibrated temperature range at normal system operating temperatures:

      1) Chilled water: 0.5ºF
      2) Hot Water: 2.0ºF
      3) Condenser Water: 0.5ºF
      4) Heat Pump or process: 2.0ºF

   b. TAB shall work with the BAS contractor to calibrate sensors.
   c. TAB shall notify appropriate responsible contractor of gauge or sensor deficiency for the above to be re-calibrated or replaced.
   d. Replaced gauges shall be verified for accuracy by TAB.

3. Pressure Gauges and BAS Sensors – Air Systems

   a. The installed pressure gauges and BAS pressure sensors shall be within 10% of the TAB contractor's calibrated gauge at the normal operating pressures.
   b. TAB shall notify the responsible contractor of gauge or sensor deficiency for the above to be re-calibrated or replaced.
   c. Replaced gauges shall be verified for accuracy by TAB.
   d. The following are the tolerances for various pressure gauges and sensors:

      1) Filters: +/- 10%
      2) Duct: +/- 10%
      3) Space: +/-0.01"
      4) Isolation Room: +/- 0.001" wg

4. Thermometers and BAS Sensors – Air Systems

   a. The installed duct thermometers shall be within 1F of the TAB contractors calibrated gauge.
   b. Duct or air handling unit mounted BAS sensors shall be within 1F of TAB contractor's calibrated gauge. This includes OA, MA, coil, leaving air, and return air sensors.
   c. TAB shall notify responsible contractor of accuracy deficiency, for the device to be recalibrated or replaced.

5. Air Flow Measuring Stations (AFMS)

   a. The TAB Contractor shall validate the accuracy of air flow measuring stations by taking traverse readings. The accuracy shall be within 5%.
   b. TAB shall notify responsible contractor of accuracy deficiency for the device to be recalibrated or replaced.

END OF SECTION

SECTION 23 07 00 - HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Insulation Materials:

a. Calcium silicate.
b. Cellular glass.
c. Flexible elastomeric.
d. Polyolefin
e. Mineral fiber.
f. Phenolic.
g. Polyisocyanurate.

2. Fire-rated insulation systems.
3. Insulating cements.
4. Adhesives.
5. Coatings/Mastics.
6. Lagging adhesives/coatings.
7. Sealants.
8. Factory-applied jackets.
9. Field-applied fabric-reinforcing mesh.
10. Field-applied cloths.
11. Field-applied jackets.
12. Tapes.

B. Related Sections:

1. Division 22 Section "Plumbing Insulation."
2. Division 23 Section "Metal Ducts" for duct liners.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program and are qualified in the installation of insulation and insulation products indicated and per insulation scheduled.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Calcium Silicate:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Industrial Insulation Group (The); Thermo-12 Gold.
b. Pabco Super Caltemp

2. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
3. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
4. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

G. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Cell-U-Foam Corporation; Ultra-CUF.
b. Owens Corning Corporation; Foamglas One.

2. Block Insulation: ASTM C 552, Type I.
3. Special-Shaped Insulation: ASTM C 552, Type III.
4. Board Insulation: ASTM C 552, Type IV.
5. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.

6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
7. Prefabricate insulation for valves, elbows, tees, flanges and other fittings.

H. Flexible Elastomeric: Closed-cell expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Aeroflex USA Inc.
b. Armacell LLC.

c. K-Flex

2. Flame spread and smoke developed index of 25/50 per ASTM E84.
3. Unslit or slit type with self- sealing factory installed tape with overlapping longitudinal seam seal as required to suit the installation.
4. Where scheduled for piping systems where service temperatures exceeds 220 Deg F, insulation shall be EPDM rubber based with service temperature rating of 255 Deg F 255 F minimum.

I. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; Duct Wrap.
b. Johns Manville; Microlite.
c. Knauf Insulation; Duct Wrap.
d. Manson Insulation Inc.; Alley Wrap.
e. Owens Corning; All-Service Duct Wrap.

J. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; CrimpWrap.
b. Johns Manville; MicroFlex.
c. Knauf Insulation; Pipe and Tank Insulation.
d. Manson Insulation Inc.; AK Flex.
e. Owens Corning; Fiberglas Pipe and Tank Insulation.

K. Phenolic:

1. Products: Subject to compliance with requirements, provide the following :

   a. Johns Manville; Trymer
   b. Kingspan Corp.; Koolphen K.

2. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
3. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
5. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.

L. Polyisocyanurate: Prreformed, rigid cellular polyisocyanurate material intended for use as thermal insulation.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Johns Manville; Trymer 2000XP
   b. Rmax; Thermasheath

2. Comply with ASTM C 591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F at 75 deg F after 180 days of aging.
3. Flame-spread index shall be 25 or less and smoke-developed index shall be 450 or less for thickness up to 1 inch as tested by ASTM E 84. Thicknesses greater than 1 inch are not allowed unless documentation is submitted showing a smoke developed index of 450 or less.
4. Fabricate shapes according to ASTM C 450 and ASTM C 585.
5. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.

M. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C534/C534M or ASTM C1427, Type I, Grade 1, for tubular materials and with Type II, Grade 1, for sheet materials

1. Products: Subject to compliance with requirements, provide one of the following,

   a. Armacell LLC
   b. Sekisui Voltek, LLC

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, H. B. Fuller Construction Products; CP-97.
b. Foster Products, H. B. Fuller Construction Products; 81-27.

C. Cellular-Glass, Phenolic and Polyisocyanurate Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, H. B. Fuller Construction Products; CP-96.
b. Foster Products Corporation, H. B. Fuller Construction Products; 81-33.

D. Flexible Elastomeric and Polyolefin Adhesive:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Foster Products, H. B. Fuller Construction Products; 85-75
b. K-Flex, 373

E. Mineral-Fiber Adhesive: Comply with ASTM C 916 Type I/II.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, H. B. Fuller Construction Products; CP-127/CP-82.
b. Foster Products, H. B. Fuller Construction Products; 85-60/85-20.

F. ASJ Adhesive, and FSK Jacket Adhesive: Comply with ASTM C 916 Type I/II for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, H. B. Fuller Construction Products; CP-127/CP-82.
b. Foster Products Corporation, H. B. Fuller Construction Products; 85-60/85-20.

G. PVC Jacket Adhesive: Compatible with PVC jacket.

2.4 COATINGS/MASTICS

A. Vapor-Barrier Coating: Mold Resistant, water based; suitable for indoor and outdoor use on below ambient services. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II and must be QPL listed

1. Products: Subject to compliance with requirements, provide one of the following:

a. Foster Products, H. B. Fuller Construction Products; 30-80 AF.

2. Must comply with ASTM D 5590 with 0 growth rating.
3. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 permat 43-mildry film thickness.
4. Service Temperature Range: Minus 20 to plus 180 deg F.

B. Vapor-Barrier Coating: Solvent based; suitable for outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products; H.B. Fuller Construction Products; Encacel V/VI.
b. Foster Products; H.B. Fuller Construction Products; 60-95/60-96.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products; H.B. Fuller Construction Products; CP-10/CP-11.
b. Foster Products; H.B. Fuller Construction Products; 46-50.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White

2.5 LAGGING ADHESIVES/COATINGS

A. Description: Mold resistant. Shall be compatible with insulation materials, jackets, and substrates.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, H. B. Fuller Construction Products; CP-137 AF.
b. Foster Products, H. B. Fuller Construction Products; 30-36 AF.

2. Must comply with ASTM D 5590 with 0 growth rating.
3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
4. Service Temperature Range: Minus 50 to plus 180 deg F.

2.6 SEALANTS

A. Joint Sealants:

1. Products: Subject to compliance with requirements, provide one of the following

a. Childers Products, H. B. Fuller Construction Products; CP-76/CP-70.
b. Foster Products, H. B. Fuller Construction Products; 30-45/95-50.
c. Pittsburgh Corning Pittseal 444N or 727

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, sealant.
4. Service Temperature Range: Minus 100 to plus 200 deg F.
5. Color: White, gray, tan, or aluminum

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, H. B. Fuller Construction Products; CP-76/CP-70.
b. Foster Products, H. B. Fuller Construction Products; 95-44/30-45.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Gray or Aluminum

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide the following :

a. Childers Products, H. B. Fuller Construction Products; CP-76/CP-70.
b. Foster Products, H.B. Fuller Construction Products; 95-44/30-45.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Gray or Aluminum

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch for covering pipe and pipe fittings.

1. Childers Chil Glas #10
2. Vimasco 894

B. Woven Glass-Fiber Fabric for Duct and Equipment Insulation: Approximately 0.9 oz/sq. yard. with a thread count of 9 strands by 8 strands/sq. inchfor covering equipment.

1. Foster Mast A Fab

2.9 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Johns Manville; Zeston.
b. P.I.C. Plastics, Inc.; FG Series.
c. Proto PVC Corporation; LoSmoke.
d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: Color as selected by Architect.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

5. Factory-fabricated tank heads and tank side panels.

C. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; Metal Jacketing Systems.
b. PABCO Metals Corporation; Surefit.
c. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.

a. Sheet and roll stock ready for shop or field sizing.
b. Finish and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Indoor or Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.

2.10 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Width: 3 inches.
2. Thickness: 11.5 mils.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.

1. Width: 2 inches.
2. Thickness: 6 mils.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Install joint sealant for all longitudinal and butt joints.

K. Insulation is required for all systems and equipment operating below 70 F and above 105 F.

L. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

M. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

N. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.

   a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with fab and mastic to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

O. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

P. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

Q. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

R. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.

6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Pipe: Install insulation continuously through floor penetrations.

3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves and strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
5. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
6. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
7. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
8. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

3.6 CALCIUM SILICATE INSULATION INSTALLATION

A. Insulation Installation on Boiler Breechings, Ducts, Straight Pipes, and Tubes:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation material.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

3.7 CELLULAR-GLASS INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

3.8 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.9 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Blanket or Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

   a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not overcompress insulation during installation.
   e. Impale insulation over pins and attach speed washers.
   f. Cut excess portion of pins extending beyond speed washers insulation surface. Cover exposed pins and washers with fab and mastic.

4. For all ducts and plenums, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. All joints, seams and punctures shall be sealed with fabric and mastic. Secure laps to adjacent insulation section with 1/2-inchoutward-clinching staples, 6 inches (150

mm) o.c. Cover all joints, seams and punctures with minimum 3" wide glass cloth cloth fabric set in mastic. After first coat is dry, apply second coat of mastic.

7. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
8. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.10 PHENOLIC INSULATION INSTALLATION

A. General Installation Requirements:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.

B. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets with vapor retarders on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

3.11 POLYISOCYANURATE INSULATION INSTALLATION

A. Installation near fire resistance rated barriers.

1. Polyisocyanurate insulation is not allowed where penetrations pass through a fire resistance rated barrier. Another type of insulation must be used within 10 feet of any fire resistance rated barriers.

B. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.

2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

3.12 POLYOLEFIN INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as that of pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of polyolefin pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

E. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated

3.13 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.14 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

B. Do not field paint aluminum or stainless-steel jackets.

3.15 DUCT INSULATION SCHEDULE, GENERAL

A. Ductwork insulation includes all apparatus casings such as air terminal devices, duct heating coils, filters, mixing chambers, sound attenuators, etc., which shall be insulated in accordance with applicable ductwork insulation specifications.

B. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply, return, and outdoor air.
2. Indoor, exposed supply, return, and outdoor air.
3. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
4. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
5. Outdoor, concealed supply and return.
6. Outdoor, exposed supply and return.
7. Flexible connectors.
8. Vibration-control devices.

C. Items Not Insulated:

1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
2. Double wall ducts.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Factory-insulated access panels and doors.

3.16 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Unconditioned spaces shall be considered to be outdoors.

B. Concealed supply-air, return-air, and outside-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

3.17 ABOVEGROUND, EXTERIOR DUCT AND PLENUM INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.

B. Round and flat-oval, supply-air, return-air, and outside-air duct insulation and plenums and exhaust ducts in energy recovery systems shall be one of the following:

1. Mineral-Fiber Blanket: 3 inches and 0.75-lb/cu. ft. nominal density.

C. Rectangular, supply-air, return-air, and outside-air duct insulation and plenums and exhaust ducts in energy recovery systems shall be one of the following:

1. Cellular Glass: 3 inches thick.
2. Polyisocyanurate: 3 inches thick.

3.18 DIFFUSER PLENUMS, BACKS AND NECKS INSULATION SCHEDULE

A. Insulate the back of supply diffusers, diffuser plenums and necks of diffusers with the same insulation material and thickness as specified for the ductwork system it is connected to

3.19 ZONE REGISTER TERMINAL BOXES

A. Insulate the back of zone register terminal boxes (ZRT) when box is used to deliver cold outdoor air with the same insulation material and thickness as specified for the ductwork system it is connected to. ZRT's delivering neutral air is not require to be insulated.

3.20 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated unless noted otherwise.

C. For equipment exposed to outdoor air, increase the thickness shown in the schedule below by ½" (in.).

3.21 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

C. For piping exposed to outdoor air, increase the thickness shown in the schedule below by ½" (in.).

3.22 PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 1/2 inch thick

b. Polyolefin: 1/2 inch thick.

B. Heating-Hot-Water Supply and Return:

1. Pipe size NPS 1 1/4and smaller: Insulation shall be one of the following:

a. Cellular Glass: 1 1/2 inches. thick
b. Mineral-Fiber, Preformed Pipe: 1 1/2 inches thick. Use limited to interior applications only.
c. Phenolic: 1 inch thick. Use limited to exterior above ground applications only.

2. Pipe size larger than NPS 1 1/4: Insulation shall be one of the following:

a. Cellular Glass: 2 inches. thick

b. Mineral-Fiber, Preformed Pipe: 2 inches thick. Use limited to interior applications only.
c. Phenolic: 1 inch thick. Use limited to exterior above ground applications only.

C. Steam and Steam Condensate, 250 Deg F 15 Psig and below:

1. Smaller than NPS 1 1/4: Insulation shall be one of the following:

a. Calcium Silicate: 4 inches thick.
b. Mineral-Fiber, Preformed Pipe: 21/2 inches thick. Use limited to interior applications only

2. NPS 1 1/4 to smaller than NPS 4: Insulation shall be one of the following:

a. Calcium Silicate: 5inches thick.
b. Mineral-Fiber, Preformed Pipe: 21/2 inches thick. Use limited to interior applications only.

D. VRF Refrigerant Cold Piping:

1. Flexible Elastomeric: 1 inch thick.
2. Polyolefin: 1 inch thick.

E. VRF Refrigerant Hot Piping:

1. Daikin and LG (Greater than 220 Deg F Service Temperature):

a. All Pipe Sizes: Insulation shall be the following:

1) Flexible Elastomeric (EPDM Based): 2 1/2 inches thick.

2. Mitsubishi/Trane (Less than 220 Deg F Service Temperature):

a. Pipe sizeNPS 1 1/4and smaller: Insulation shall be one of the following:

1) Flexible Elastomeric: 1 1/2 inches thick

b. Pipe size larger thanNPS 1 ¼ and smaller than NPS 4: Insulation shall be one of the following:

1) Flexible Elastomeric: 2 inches thick.

3.23 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Exterior weather cladding shall be installed per manufacturer’s installation instructions.

C. If more than one material is listed, selection from materials listed is Contractor's option.

D. Ducts and Plenums,:

1. Aluminum, Smooth: 0.024 inch thick.

E. Piping and Equipment:

1. Aluminum, Stucco Embossed: 0.024 inch thick.

END OF SECTION

SECTION 23 08 00 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1. Refer to Division 01 General Requirements – Specification Section 01 91 13 "General Commissioning Requirements" for the commissioning process requirements applicable to Division 23**.**

1.2 SUMMARY

A. This section includes general requirements that apply to implementation of commissioning without regard to specific systems, assemblies or components.

B. The following systems/equipment shall be commissioned:

1. HVAC – Division 23; HVAC Equipment, Building Automation System (BAS), Test Adjust and Balance – Air/Water.

C. The commissioning process does not take away from or reduce the responsibility of the Contractor to provide a finished and fully functioning project. Commissioning is essentially a quality management process of observing and documenting that the equipment and systems operate and perform as intended.

D. The commissioning testing shall be based upon the following reference standards: Building Commissioning Association (www.bCxP.org); ASHRAE Guideline 0-2005, The Commissioning Process.

1.3 DEFINITIONS

A. Abbreviations: The following are common abbreviations:

1. A/E – Architect and design engineers
2. Cx – Commissioning
3. CxP – Commissioning Provider
4. Cx Plan – Commissioning Plan document
5. FPT – Functional-Performance Test
6. GC – General Contractor
7. HVAC – Heating, Ventilation, and Air Conditioning
8. IST – Integrated Systems Test
9. TAB – Test, Adjust, and Balance

B. Cx Plan: A document that provides the following:

1. A narrative description of the activities that will be accomplished during each phase of commissioning, including the personnel intended to accomplish each of the activities.
2. A listing of the specific equipment, appliances or systems to be tested and a description of the tests to be performed.
3. Functions to be tested including, but not limited to, calibrations and economizer controls.
4. Conditions under which the test will be performed including but not limited to winter and summer design conditions and full outside air conditions.
5. Measurable criteria for performance.

C. Preliminary Commissioning Report – A preliminary report of commissioning test procedures and results prepared and certified by a licensed design professional, electrical engineer, mechanical engineer or approved agency, and is provided to the building owner or owner's authorized agent. The report, organized with mechanical and service hot water and lighting in separate sections includes at a minimum, the following:

1. Itemization of deficiencies found during testing that have not been corrected at the time of the report.
2. Deferred tests that cannot be performed at the time of the report preparation because of climatic conditions.
3. Climatic conditions required for performance of the deferred tests.
4. Results of functional performance tests.
5. Functional performance test procedures used during the commissioning process, including measurable criteria for test acceptance.

D. Final Commissioning Report – A report of final test procedures and results identified which is provided to the building owner or owner's authorized agent. The report, organized with mechanical and service hot water and lighting in separate sections includes at a minimum, the following:

1. Results of functional performance tests.
2. Disposition of deficiencies found during testing, including details of corrective measures used or proposed.
3. Functional performance test procedures used during the commissioning process including measurable criteria for test acceptance.
4. Deferred tests that cannot be performed at the time of the report preparation because of climatic conditions.

E. CxP: Commissioning Provider/Person(s) that directs and coordinates the commissioning activities.

F. FPT: Test that verifies the proper operation of equipment or system. The systems are run through all the control system's sequences of operation and components are verified to be responding as the sequences state including performance of all alarms and operator user interfaces. Tests also require operation under various modes, such as during low cooling

or heating loads, part loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, restoration of power, redundant or automatic back-up mode, etc.

G. IST: Test intended to supplement the Functional-Performance Tests and to specifically address equipment interoperation, systems interoperation, design space loading, failure scenarios and/or overall system survivability. Completion of associated Functional-Performance Tests is required prior to execution of IST(s).

H. Seasonal Tests: Tests that are deferred until the system(s) will experience outdoor weather conditions closer to their design conditions. Trend data from the building automation system contractor may be used to evaluate equipment performance for seasonal testing.

1.4 QUALIFICATIONS

A. There are no qualifications required of the mechanical contractor.

1.5 SUBMITTALS

A. There are no qualifications required of the mechanical contractor.

1.6 COMMISSIONING PROVIDER

A. The Commissioning Provider shall be provided by the Owner. The contractor and sub-contractors are responsible to execute the commissioning process according to this Section.

B. The Commissioning Provider shall be provided by the Division 1 Contractor. The contractor and sub-contractors are responsible to execute the commissioning process according to this Section.

1.7 COMMISSIONING TEAM

A. Members Appointed by Contractor(s): Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action. The commissioning team shall consist of, but not be limited to, representatives from the Contractor, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxP.

B. Members Appointed by Owner:

1. CxP: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. Owner will engage the CxP under a separate contract.

2. Representatives of the facility user and operation and maintenance personnel.
3. Architect and engineering design professionals.

1.8 RESPONSIBILITY MATRIX

A. The following responsibility matrix outlines the major tasks of the commissioning process and the parties responsible to carry out the tasks. The shaded cells in the following table reflect the major effort for each task/action.

Event / Documentation	**Responsibility**				
	CxP	**Owner / A/E**	**GC/CM**	**MEP/TAB Contrac-tor**	**BAS Contrac-tor**
Prepare Cx Plan	Create/ Update	Review	Review	Review	Review
Functional-Performance Tests (FPT)	Observe / Docu-ment	Observe	Schedule	Execute	Execute
Cx Issues Log	Write / Update	Review	Verify Comple-tion	Correct	Correct
Preliminary Commissioning Report	Write	Review	Review	Review	Review
Seasonal Testing	Observe / Docu-ment	Observe	Schedule	Execute	Execute
Final Cx Report	Write	Review	No Action	No Action	No Action

1.9 CONTRACTOR'S RESPONSIBILITIES

A. Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:

1. Include scope to complete commissioning requirements in the Contract price.
2. Integrate and coordinate commissioning process activities with construction schedule. Include time in the project schedule for completion of Functional-Performance Tests. Include time for resolution of deficiencies found during Functional-Performance Tests.
3. Review and accept commissioning process Functional-Performance Test procedures provided by the Commissioning Provider.
4. Attend commissioning scheduling and coordination meetings as requested.
5. Execute the Functional-Performance tests while the CxP witnesses and documents.

6. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
7. Cooperate with the CxP for resolution of issues recorded in the Issues Log.
8. Attend commissioning team meetings typically held each day the CxP is on-site (either prior to or immediately following the day's tests).
9. For Seasonal Testing, provide personnel at the project site to execute testing during peak heating and/or cooling season(s).
10. Complete Functional-Performance Test procedures.

1.10 BUILDING AUTOMATION SYSTEM (BAS) CONTRACTOR

A. The BAS Contractor shall execute most of the HVAC Functional-Performance testing. BAS contractor shall assign representatives with expertise and authority to act on their behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to Section 1.9 above and the following:

1. Review the Functional-Performance Tests developed by the CxP to ensure that control system points are in place to execute the tests. Recommend test revisions to streamline or improve the test procedures.
2. Calibrate all sensors prior to commencing functional performance testing. Provide calibrated handheld test equipment (for airflow, temperature, humidity, amperage, pressure, etc.) as dictated within the Functional-Performance Tests for use during on-site testing
3. Provide controls system technician intimately familiar with the system for use during witnessing of the Functional-Performance Tests
4. Demonstrate BAS system performance to Commissioning Provider during witnessing of the Functional-Performance Tests including all modes of system operation, alarm reporting, execution of commands, etc.
5. This project includes Seasonal Testing. Completion of Seasonal Testing may be achieved through the use of submitted trend data. Provide trends as outlined in the seasonal Functional-Performance Test. Trends shall be submitted to CxP within 3 business days of initial request and shall demonstrate stability of control and equipment capacity during peak heating and/or cooling season(s). Trend data may be submitted in graphical or tabular form. Duration of trend data shall span a minimum of 24 hours with minimum polling frequencies as follows:

a. Analog input – every 60 seconds
b. Analog output – every 60 seconds
c. Binary input – change of state
d. Binary output – change of state

1.11 Provide personnel at the project site to execute Seasonal Testing during peak heating and/or cooling season(s). Remote testing (via submitted trend data) is acceptable only if the submitted trends accurately depict a fully functional system at design capacity.

1.12 TEST, ADJUST, AND BALANCING (TAB) CONTRACTOR

A. TAB contractor shall assign representatives with expertise and authority to act on their behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:

1. Provide TAB technician intimately familiar with the project for use during verification of TAB.
2. Submit Engineer-approved TAB report to CxP in advance of TAB verification by CxP. If an approved report is not available, provide preliminary report.
3. Take measurements requested by the CxP during TAB verification with the same instruments used during original TAB Work. CxP will expect to observe the same measurements as those indicated in TAB Report (+/- testing equipment accuracies).
4. Provide calibrated handheld test equipment (for airflow, temperature, humidity, amperage, pressure, etc.) as dictated within the Functional-Performance Tests for use during on-site testing.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 FUNCTIONAL-PERFORMANCE TESTING

A. CxP will create an FPT for each type of equipment within the Cx scope of work.
B. The Division 1 Contractor shall determine which subcontractor(s) is/are responsible for the Functional-Performance Test execution for each specific piece of equipment.
C. The Division 1 Contractor shall have the responsible subcontractor review and approve Functional-Performance Tests prepared by CxP to ensure they are applicable to the project, can be performed, and will not damage equipment.
D. The CxP will schedule through the Division 1 Contractor the Functional-Performance Test witnessing of selected pieces of equipment / systems.
E. The following is a summary of the systems that are intended to be Functional-Performance Tested as part of this project:

HVAC Systems (Division 23)

System or Equipment	Equipment or Component Tested	General Description of Modes and Functions to Test	Test Strategy	Seasonal Test
Air Handling System, Exhaust Air Handling Units	AHU, supply, return, exhaust fans, coils, coil pumps, valves, dampers, VFDs, controls, reheat coils.	All sequences of fans and related components (startup, shutdown, unoccupied mode, load changes, resets, alarms, lockouts), VFD control, operation of all dampers in all modes, emergency power, coil capacity, outside air control.	Test all air handling units.	Anytime
Tenant Terminal Units	VAV or CV boxes, fan-coil unit,	Verify damper and fan sequences during heating,	Test 25%	Anytime.

System or Equipment	Equipment or Component Tested	General Description of Modes and Functions to Test	Test Strategy	Seasonal Test
	thru-wall unit, unit heaters.	cooling, occupied, unoccupied modes. Check deadbands, verify flow.		
Fans	Supply, central exhaust, stairwell pressurization, garage, etc.	All sequences, occupied, unoccupied, local control, overrides, schedules, control sequences. Testing of stairwell pressurization fans is for functionality and not for AHJ acceptance	Test all.	Anytime.
Building Automation System	Schedules, sequences, lockouts, alarms, interlocks, control strategies, trending, graphics	All sequences of controls for mechanical equipment and lighting controls.	Test all controlled equipment.	Anytime.
Test & Balance	Air and Water	Verify air handling unit water coil balancing and air flow measuring stations. Sample tenant water coil balancing	All air handling units, test min. 25% terminal units	Anytime.

3.2 INTEGRATED SYSTEM TESTING

A. CxP will provide the Division 1 Contractor a list of systems included in Integrated System Testing (IST).
B. The Division 1 Contractor shall determine all affected subcontractor(s) and ensure appropriate personnel is available to perform the Integrated Systems Test for the designated system(s).
C. The Division 1 Contractor shall have the responsible subcontractor review and approve Integrated System Tests prepared by CxP to ensure they are applicable to the project, can be performed and will not damage equipment.
D. The Integrated System Test for each system shall not be executed until the Functional-Performance Tests for all associated equipment have been successfully completed and documented by the CxP
E. Assist the CxP in scheduling the Integrated System Tests.

3.3 NON-CONFORMANCE AND RETESTING

A. Non-Conformance.

1. The CxP will record the results of the testing. All deficiencies, non-conformance issues, or test failures shall be noted and reported to the Contractors in the Issues Log, maintained by the CxP in a punch-list format.
2. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxP. In such cases the deficiency and resolution will be documented on the procedure form.
3. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures; however, the CxP will not be pressured into overlooking deficient Work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so at the request of the Owner's Representative.

B. Re-testing.

1. The Contractor shall retest the equipment until all deficiencies have been resolved and provide signatures where applicable on the Functional-Performance Test form indicating that the deficiency has been corrected. The CxP will witness retesting at their discretion based on the criticality of the deficiency and time available on site.
2. The time/cost for the CxP to perform any re-testing will be back-charged to the Division 1 Contractor if either (a) an item was overlooked in the prerequisite documentation or (b) completion of an item was misrepresented in the prerequisite documentation. The Division 1 Contractor may then choose to recover costs from the party responsible for the item.
3. Re-testing by any contractor shall not be considered a justified reason for a claim of delay or for a time extension by the Division 1 Contractor. The contractors will be provided with the commissioning test forms in advance to perform the tests as part of their checkout procedures.

3.4 DEFERRED TESTING

A. Unforeseen Deferred Tests. If any Test cannot be completed due to the building structure, required occupancy condition or other deficiency, execution of Testing may be delayed upon approval of the Owner. These tests shall be conducted in the same manner as the seasonal tests as soon as possible. Services of necessary parties due to unforeseen deferred testing will be negotiated.

END OF SECTION

SECTION 23 09 00 – INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

B. Related Sections include the following:

1. Division 23 Section "Control Sequences" for HVAC Sequences of Operation.
2. Division 23 Section “Commissioning of HVAC” for requirements that relate to this section.
3. Division 23 Section “Variable Frequency Motor Controllers” for requirements that relate to this section.
4. Division 26 Section “Digital, Addressable Fire Alarm System” for requirements that relate to this section.
5. Division 1 Section “General Commissioning Requirements” for requirements that relate to this section.

1.3 DESCRIPTION OF SYSTEM

A. Furnish and install an extension of the existing Building Automation System, BAS, utilizing Direct Digital Controls, DDC, in accordance with drawings, specifications and intent of the design.

B. The new DDC BAS components shall be tied into the existing BAS network. The expanded BAS system shall be compatible and by the same manufacturer of the existing system and shall be complete in all respects. All DDC parameters shall be available through the BAS network and existing operator workstation. System access is provided by the operator workstation, network terminal and remote access via modem by manufacturer.

1. The design intent is to provide upgrades to and utilize the existing software interface at the BAS existing operator workstation. The operator interface description as indicated in the specifications indicates the capabilities of the work station. Software upgrades to utilize workstation capabilities including graphical interface is a requirement of these specifications as required to perform HVAC equipment sequences specified.

C. The BAS shall comply with the latest ANSI/ASHRAE Standard 135, BACnet. This system is to control all mechanical equipment, including all unitary equipment such as VAV boxes, heat pumps, fan-coils, AC units, etc. and all air handlers, boilers, chillers, and any other listed equipment using native BACnet-compliant components.

D. All components not specifically indicated or specified, but necessary to make the system function within the intent of the specification, are to be included.

E. Size all control apparatus to properly supply and/or operate and control the apparatus served.

F. All electrical products shall be listed and labeled by UL and comply with NEMA Standards.

G. All electrical work required as an integral part of the Building Automation System is the responsibility of the control contractor, including but not limited to control wiring, interlock wiring, electrical wiring, smoke dampers, and associated control power wiring including power to control panels. This is in addition to power indicated to control panels for air handling units and other pieces of mechanical equipment. All control wiring and conduit shall comply with NEC and Division 26 Specifications.

H. All wiring shall be installed in conduit within walls or inaccessible ceiling spaces. MC Cable is acceptable for inaccessible ceiling spaces. Wiring/cabling can be run exposed on j-hooks above accessible ceiling areas. Provide plenum rated cabling as required.

I. All computing devices, as defined in FCC Rules and Regulations, Part 15, shall be verified to comply with the requirements for Class A computing devices and labeled as set forth in FCC Rules and Regulations, Part 15.

J. Field Enclosures: Enclosures shall conform to the requirements of the NEMA types. NEMA 4X shall be used outdoors near cooling towers and within 3 miles of the ocean. Finish color shall be of the manufacturer’s standard, unless otherwise stated. Damaged surfaces shall be repaired and/or refinished to its original condition.

K. Provide remote communication to the BAS system.

L. Any control devices subject to corrosion, such as in fume hood exhaust duct or in pool or in seacoast atmosphere, shall be provided with appropriate corrosion protection.

1.4 DEFINITIONS

A. ANALOG: A continuously varying signal value, such as current, flow, pressure, or temperature.

B. BAS: Building Automation System

C. BINARY: Two-state signal where a high signal level represents ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.

D. DDC: Direct digital control.

E. I/O: Input/output.

F. MS/TP: Master slave/token passing.

G. PID: Proportional plus integral plus derivative.

H. RTD: Resistance temperature detector.

1.5 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:

1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows unless noted otherwise:

a. Water Temperature: Plus or minus 1 deg F.
b. Water Flow: Plus or minus 2 percent of reading.
c. Water Pressure: Plus or minus 2 percent of full scale.
d. Space Temperature: Plus or minus 1 deg F.
e. Ducted Air Temperature: Plus or minus 1 deg F.
f. Outside Air Temperature: Plus or minus 2 deg F.
g. Dew Point Temperature: Plus or minus 3 deg F.
h. Temperature Differential: Plus or minus 0.25 deg F.
i. Relative Humidity: Plus or minus 5 percent.
j. Airflow (Measuring Stations): Plus or minus3 % to 10% of reading, refer to Part 2 for specific requirements.
k. Airflow (Terminal): Plus or minus 10 percent of full scale.
l. Air Pressure (Critical Space): Plus or minus10% of reading.
m. Air Pressure (Building): Plus or minus 1% of full scale.
n. Air Pressure (Ducts): Plus or minus 1% of full scale.
o. Electrical: Plus or minus 5 percent of reading.

1.6 SEQUENCE OF OPERATION

A. Refer to Division 23 Sections for Control Sequences.

1.7 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. DDC System Hardware: Bill of materials of equipment indicating manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
3. Wiring Diagrams: Power, signal, and control wiring.
4. Details of control panel faces, including controls, instruments, and labeling.
5. Schedule of dampers including size, leakage, and flow characteristics.
6. Schedule of valves including flow characteristics.
7. DDC System Hardware:

a. Wiring diagrams for control units with termination numbers.
b. Schematic diagrams and floor plans for field sensors and control hardware.
c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.

8. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
9. Controlled Systems:

a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.

c. Written description of sequence of operation including schematic diagram.
d. Points list.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:

1. Interconnection wiring diagrams with identified and numbered system components and devices.
2. Keyboard illustrations and step-by-step procedures indexed for each operator function.
3. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
4. Calibration records and list of set points.
5. The Building Automation System contractor shall furnish to the Engineer, upon completion of the work, but before final acceptance of the system, a pdf copy of instructions covering complete maintenance and operation of the system and a complete set of as-built drawings of control diagrams.
6. Maintenance instructions shall include manufacturer's literature on all system equipment components. All maintenance instructions shall be explicit concerning time intervals for all servicing and preventative maintenance, types and grades of oil and/or grease, packing materials, normal and abnormal clearance, methods of equipment adjustments, and a complete description of replacement parts and materials for wearing items.
7. Upon completion of the installation, the control contractor shall submit to the Owner a proposal to provide the necessary programmed maintenance to keep the system in proper working condition. This proposal shall fully describe the maintenance cost of this work during the guarantee period as well as for subsequent years thereafter.
8. List of spare parts for each type of control device.
9. Contact names and 24 hour telephone numbers for service..
10. A list and documentation of all custom software created.
11. ACAD files for the drawings, BAS software files, database files and files of all color graphic screens created for the project.
12. Guarantees and warranty documents for all equipment and systems.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On disc, complete with data files and graphic screens.
3. Device address list.
4. Software license for DDC workstations and control systems.

C. Training Manuals: The contractor shall provide a course outline and training manuals for all training classes for Engineer’s and Commissioning Authority if one exists review. The Engineer or Commissioning Authority may modify training materials to meet the needs of

the Owner. Review and approval by the Engineer shall be completed prior to substantial completion and the first training class

1.9 QUALITY ASSURANCE

A. Installer Qualifications: The control system shall be installed by competent control technicians under the direct employment of local branch office of the manufacturer of the control equipment. All control equipment shall be the product of one manufacturer. The control contractor shall have local maintenance capabilities available within a 100 mile radius of the project site. The control contractor must have installed Direct Digital Controls of the type and manufacturer specified for at least five years prior to commencing this project.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.10 GUARANTEE/MAINTENANCE

A. Guarantee the BAS to maintain the temperature in rooms within one degree of the setting and further guarantee all work, materials equipment, and controls against defects in workmanship and material and provide service for a period of one (1) year from date of final acceptance.

B. Replace any defective workmanship or material developing within that time as soon as possible at no charge to the Owner.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. Field-Installed Components: Shall be protected per Division 23 Section “Common Work Results for HVAC”

1.12 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate equipment with Division 26 Section "Network Lighting Controls" to achieve compatibility with equipment that interfaces with that system.

C. Coordinate equipment with Division 26 Section "Digital Addressable fire alarm system." to achieve compatibility with equipment that interfaces with that system.

D. Coordinate equipment with Division 26 Section "Electricity Metering" to achieve compatibility of communication interfaces.

E. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.

F. Coordinate equipment with Division 26 Section "Motor-Control Centers" to achieve compatibility with motor starters and annunciation devices.

G. Coordinate equipment with Division 28 Section "Electronic Access Control Systems" to achieve compatibility with equipment that interfaces with that system.

PART 2 - PRODUCTS

2.1 CONTROL SYSTEM

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Siemens Building Technologies, Inc.

B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, power supplies, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment and programmed to control mechanical systems. Control system shall be on a dedicated network. The use of the building IT network may be utilized for communication if owner approval is received. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

2.2 DDC EQUIPMENT

A. Utilize existing operator work station.

B. Application Software:

a. I/O capability from operator station.
b. System security for each operator via software password and access levels.
c. Automatic system diagnostics; monitor system and report failures.
d. Database creation and support.
e. Automatic and manual database save and restore.
f. Dynamic color graphic displays with up to 10 screen displays at once.
g. Custom graphics generation and graphics library of HVAC equipment and symbols.
h. Alarm processing, messages, and reactions.
i. Trend logs retrievable in spreadsheets and database programs.

j. Alarm and event processing.
k. Object and property status and control.
l. Automatic restart of field equipment on restoration of power.
m. Data collection, reports, and logs. Include standard reports for the following:

1) Current values of all objects.
2) Current alarm summary.
3) Disabled objects.
4) Alarm lockout objects.
5) Logs.

n. Custom report development.
o. Utility and weather reports.
p. ASHRAE Guideline 3 report for chillers.
q. Workstation application editors for controllers and schedules.
r. Maintenance management.

C. Custom Application Software:

a. English language oriented.
b. Full-screen character editor/programming environment.
c. Allow development of independently executing program modules with debugging/simulation capability.
d. Support conditional statements.
e. Support floating-point arithmetic with mathematic functions.
f. Contains predefined time variables.

D. Diagnostic Terminal Unit: Portable notebook-style, PC-based microcomputer terminal or tablet capable of accessing system data by connecting to system network.

E. Control Units: Modular, comprising of processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.

1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

a. Global communications.
b. Discrete/digital, analog, and pulse I/O.
c. Monitoring, controlling, or addressing data points.
d. Software applications, scheduling, and alarm processing.
e. Testing and developing control algorithms without disrupting field hardware and controlled environment.

3. Standard Application Programs:

a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
c. Chiller Control Programs: Control function of condenser-water reset, chilled-water reset, and equipment sequencing.
d. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
e. Remote communications.
f. Maintenance management.
g. Units of Measure: Inch-pound and SI (metric).

4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.

F. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.

1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

a. Global communications.
b. Discrete/digital, analog, and pulse I/O.
c. Monitoring, controlling, or addressing data points.

3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.

G. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

1. Binary Inputs: Allow monitoring of on-off signals without external power.
2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.

7. Universal I/Os: Provide software selectable binary or analog outputs.

2.3 WEB ACCESS

A. DDC system shall be Web compatible.

1. Web-Compatible Access to DDC System:

a. Workstation and server shall perform overall system supervision and configuration, graphical user interface, management report generation, and alarm annunciation.
b. DDC system shall support Web browser access to building data. Operator using a standard Web browser shall be able to access control graphics and change adjustable set points.
c. Web access shall be password protected.

2.4 DDC SYSTEM WIRELESS NETWORKS

A. In lieu of wired control network, wireless networks are acceptable. Wireless control system shall meet all of the provisions of this specification.

B. Use Zigbee or an open industry standard and technology used by multiple BAS system manufacturers technology to create a wireless mesh network to provide wireless connectivity for network devices at multiple system levels including communications from programmable controllers and to temperature sensors and from network controllers to programmable controllers.

C. Installer shall design wireless networks to comply with BAS system performance requirements indicated. Wireless network devices shall co-exist on same network with hardwired devices.

D. Hardwired controllers shall be capable of retrofit to wireless devices with no special software.

2.5 POWER SUPPLY

A. Power Supplies: UL listed transformers with Class 2 current-limiting type or overcurrent protection for AC or DC power for each DDC controller and module. Limit connected loads to 80 percent of rated capacity.

1. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

a. Output ripple of 5.0 mV maximum peak to peak.
b. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.

c. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

B. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:

1. Minimum dielectric strength of 1000 V.
2. Maximum response time of 10 nanoseconds.
3. Minimum transverse-mode noise attenuation of 65 dB.
4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.6 UNINTERRUPTIBLE POWER SUPPLY SYSTEM

A. Provide small plug-in UPS for all BAS control system field panels. The UPS shall be sized for application plus 20% spare capacity. If the UPS device will not fit inside a BAS control panel, then provide an adjacent cabinet for the UPS. Control panels shall be equipped with a receptacle for UPS connection to utility power. Provide one UPS for each systems level control panel and for the chiller plant control panel.

B. The capacity of the UPS shall be sized for no less than one minute. The purpose of the UPS shall be to maintain the BAS network traffic and prevent a complete BAS system restart in the event of a short utility power disruption.

C. All equipment connected to the BAS shall include automatic restarting upon loss of utility power or network communication for any reason.

2.7 UNITARY CONTROLLERS

A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.

1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms.
3. Enclosure: In conditioned spaced, dustproof rated for operation at 32 to 120 deg F. In outdoor applications or in wet ambient conditions, waterproof rated for operation at minus 10 to 150 deg F.

2.8 ANALOG CONTROLLERS

A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.

B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F, and single- or double-pole contacts.

C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.

1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.

2.9 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Temperature Sensors: RTDs and Transmitters.

1. Accuracy: Plus or minus 0.2 percent at calibration point.
2. Wire: Twisted, shielded-pair cable.
3. Insertion Elements in Ducts: Single point; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft..
4. Averaging Elements in Ducts and Air Handling Units: 24 feet long, flexible; use where prone to temperature stratification or where ducts are larger than 9 sq. ft.; length as required. Provide averaging sensors for all mixed air applications.
5. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
6. Room Sensor Cover Construction: Manufacturer's standard display and covers.

a. Set-Point Adjustment: Concealed for public areas.

7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
8. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

C. Humidity Sensors: Bulk polymer sensor element.

1. Accuracy: 2 percent full range with linear output.
2. Room Sensor Range: 20 to 80 percent relative humidity.
3. Room Sensor Cover Construction: Manufacturer's standard locking covers.
4. Duct Sensor: 0 to 100 percent relative humidity range with element guard and mounting plate.
5. Outside-Air Sensor: 0 to 100 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of minus 22 to plus 185 deg F.

D. Pressure Transmitters/Transducers:

1. Manufacturers:

   a. BEC Controls Corporation.
   b. Dwyer.
   c. General Eastern Instruments.
   d. MAMAC Systems, Inc.
   e. ONICON Incorporated.
   f. Senva.
   g. Veris.
   h. Vaisala.
   i. or equal standard products of the BAS manufacturer.

2. Static-Pressure Transmitter: Bidirectional sensor for ducts, plenums, air filters, dampers, fans and non-critical building pressure applications. Suitable range for expected input, and temperature compensated and automatic zeroing. Provide transmitter suitable for application with pressure range of +/-1.0" or +/-10"w.g. and shall have four switch selectable sub-ranges within each option. Make: Veris or equal.

   a. Accuracy: 1 percent of full scale of selected range with repeatability of 0.5 percent.
   b. Output: linear field selectable of 0-10V or 4 to 20 mA.
   c. Proof Pressure: 3 psid
   d. Building Static-Pressure Range: +/-0.25-inch wg.
   e. Duct, air filters Static-Pressure Range: +/- 5-inch wg.
   f. Fan and damper Static-Pressure Range: to suit application.
   g. Suitable for operating range of -20° F to 140° F. (-28.9° C to 60° C) non-condensing.

E. Room sensor accessories include the following:

1. Insulating Bases: For sensors located on exterior walls.
2. Guards: Locking; heavy-duty, transparent plastic; mounted on separate base.

2.10 SPACE MULTI-SENSOR

A. Manufacturers:

1. Belimo
2. Senva.
3. Veris.
4. Vaisala.
5. or equal standard products of the BAS manufacturer.

B. Space sensor with display for temperature and humidity microprocessor based with set point adjustments, override feature and USB connection. Provide with optional CO2 sensor, occupancy sensor, IAQ sensors as noted on the plans or required by sequence of operation. Sensors provided with BacNET network interface to facility control system.

1. Temperature sensor: Range and accuracy as specified for temperature sensors.
2. Humidity sensor: Range and accuracy as specified for humidity sensors.
3. CO2e sensor: Range and accuracy as specified for CO2 sensor.
4. Occupancy sensor: Features as specified for occupancy.

2.11 STATUS SENSORS

A. Current Sensors - Status Inputs for Fans, Pumps, and Electric Motors: Comply with ISA 50.00.01, current-sensing split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current. The smart current sensor shall be compatible with the 4-20 MA signal for the DDC panel. The current sensor shall provide a resistance change proportional to the input signal. Veris Hawkeye 921 or approved equal.

B. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.

C. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

2.12 AIR TERMINAL UNITS CONTROLLER

A. Coordinated with the Air Terminal Unit manufacturer amplified differential pressure transducer controller to read flow and damper actuator for pressure independent proportional control complete with heating control, supply air temperature sensor, space thermostat and BAS network connections. Damper controller with position feedback designed for factory mounting to air terminal unit damper and air flow assembly.

1. Transducer Manufacturers: As specified for static-pressure transmitters.
2. Actuator Manufacturer: As specified for actuators.
3. Controller with set up interface for setting minimum and maximum flow limits
4. Plenum rated polyethylene tubing or aluminum tubing from probes to pressure transducer.
5. Network connection to facility control system.
6. Bidirectional transducer with suitable range for expected input.
7. Performance:

    a. Transducer accuracy within plus or minus 10% of reading.
    b. Airflow range for operation between 325 fpm and 5000 fpm.

2.13 THERMOSTATS

A. Combination Thermostat and Fan Switches: Line-voltage thermostat with push-button or lever-operated fan switch.

B. Electric, solid-state, microcomputer-based room thermostat with remote sensor with integral battery pack.

1. Automatic switching from heating to cooling.
2. Preferential rate control to minimize overshoot and deviation from set point.
3. Set up for four separate temperatures per day.
4. Instant override of set point for continuous or timed period from 1 hour to 31 days.
5. Short-cycle protection.
6. Programming based on every day of week.
7. Selection features include degree F or degree C display, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.
8. Battery replacement without program loss.
9. Thermostat display features include the following:

a. Time of day.
b. Actual room temperature.
c. Programmed temperature.
d. Programmed time.
e. Duration of timed override.
f. Day of week.
g. System mode indications include "heating," "off," "fan auto," and "fan on."

C. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.

D. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.

1. Bulbs in water lines with separate wells of same material as bulb.
2. Bulbs in air ducts with flanges and shields.
3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
5. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.
6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.

E. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point. Provide switch with auxiliary contacts for remote notification of BAS.

1. Bulb Length: Minimum 20 feet.
2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

F. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point. Provide switch with auxiliary contacts for remote notification of BAS.

1. Bulb Length: Minimum 20 feet.
2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

2.14 HUMIDISTATS

A. Manufacturers:

1. MAMAC Systems, Inc.
2. ROTRONIC Instrument Corp.

B. Duct-Mounting Humidistats: Electric insertion, 2-position type with adjustable, 2 percent throttling range, 20 to 80 percent operating range, and single- or double-pole contacts.

2.15 ACTUATORS

A. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Manufacturers:

a. Belimo Aircontrols (USA), Inc.
b. Bray
c. Delta
d. Flow Design Inc.
e. Honeywell
f. Johnson Controls
g. Siemens
h. Or equal standard products of the BAS manufacturer.

2. Each actuator shall be of sufficient capacity to operate the damper or valve under all conditions, and to guarantee tight close-off of dampers and valves against system temperature and pressure encountered.
3. Valves: Size for torque required for valve close off at maximum pump differential pressure.
4. Dampers: Size for minimum running torque calculated as follows:

a. Parallel-Blade Damper: 7 inch-lb/sq. ft. of damper.
b. Opposed-Blade Damper: 5 inch-lb/sq. ft. of damper.
c. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by a factor of 1.5.
d. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by a factor of 2.0.

5. Coupling: V-bolt and V-shaped, toothed cradle. Provide actuators with proper linkages, mounting clamps and brackets for mounting and attaching to device. Actuators employing linkages between the actuator and damper/valve stem may be utilized subject to meeting specified requirements including additional start up requirements of Part 3.
6. Overload Protection: Electronic overload or digital rotation-sensing circuitry to prevent actuator damage due to stall throughout entire rotation. End switches to deactivate the actuator at end of rotation or magnetic clutches are not acceptable.
7. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
8. Power Requirements (Two-Position Spring Return): 24-V ac. If site conditions require the use of 120 V actuators, coordinate power requirements with the Division 26 contractor.
9. Power Requirements (Modulating): Maximum 10 VA while running and 5 VA while holding at 24-V ac or 8 W at 24-V dc.
10. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
11. Temperature Rating: Minus 22 to plus 122 deg F at 95% non-condensing relative humidity, unless noted otherwise.
12. Each actuator shall be full-proportioning or two position as indicated or specified. Provide actuators with spring return for normally open or closed position for fire freeze, moisture protection or fail safe operation on power interruption as indicated, specified and/or as required.
13. Actuators shall be constructed of galvanized steel, aluminum or stainless steel as required by applications and as specified.
14. Provide a two (2) year unconditional warrantee of actuator and, when utilized, linkages from the date of substantial completion.
15. Provide actuators with position feedback for proof of actual position and auxiliary switches as indicated in points list or sequence of operation. Position feedback is required for pump and fan control differential pressure reset.
16. The use of paralleled actuators to increase torque is acceptable.
17. Provide manufacturer's weather shield for actuators exposed to the weather.
18. Provide actuators with visual position indication.
19. Spring return actuators shall not exceed noise levels of 62 dBA when running. Non spring return actuators shall not exceed noise levels of 45 dBA when running. Spring return actuators shall include an electronic cutoff when holding at driven position so that holding noise level shall be inaudible.
20. MFT type programable proportional actuators shall be fully programmable actuators with position feedback and running time factory or field programmable. Provide Belimo MFT type actuator or approved equal. Actuator to include BACnet network connection with BAS.

B. Electronic Damper or Valve Actuators

1. Valve actuators shall include a thermal barrier and air space between valve and actuator to prevent condensation in actuator for chilled water applications.
2. Provide industrial actuators for butterfly valves 4" and larger and for damper exceeding 600 in-lbs of torque. Actuators shall include the following features:

a. Built-in thermostat and heater, pre-wired to a terminal block.
b. NEMA-4 enclosure
c. Provision for emergency manual over-ride
d. Electric motor brake
e. Accessible, adjustable end limit switches
f. Modulating actuators shall have a PC board that will allow for field changes to control input, control output, direction of rotation and calibration through pushbutton programming

3. Actuator shall be compatible with the controlled closure device requiring 7 to 15 seconds for damper closure to allow duct pressure equalizing.

2.16 CONTROL VALVES

A. Manufacturers:

1. Belimo
2. Bray
3. Flow Design Inc.
4. Honeywell
5. Johnson Controls
6. Siemens
7. Danfoss Inc.; Air Conditioning & Refrigeration Div.
8. Hayward Industrial Products, Inc.
9. Magnatrol Valve Corporation.
10. or equal standard products of the BAS manufacturer

B. The BAS Contractor shall furnish all control valves as shown on the plans and/or as required to perform the control sequence specified. Equipment may be furnished with integral control valves in accordance with specifications.

C. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

D. Hydronic system valves shall have the following characteristics:

1. Sizing: 5-psig maximum pressure drop at design flow rate or the following:

a. Two Position: Line size.
b. Two-Way Modulating: Either the value specified above or the load pressure drop, whichever is more.
c. Three-Way Modulating: The load pressure drop, but not more than value specified above.
d. Pressure Independent Control Two Way Valves: In accord with manufacturer's ratings for pressure drop and stable control.

2. Flow Characteristics: Modulating 2-way valves shall have equal percentage flow characteristics; Modulating 3-way valves shall have linear flow characteristics maintaining a constant total flow at all valve positions.
3. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head.
4. Hydronic system globe valves shall have the following characteristics:

    a. NPS 2 and Smaller: Class 250 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.

5. Characterized Ball Control Valves

    a. At the Contractor's option, characterized ball type control valves can be used for hydronic systems where sizing permits.
    b. NPS 3 and Smaller: Forged brass body with nickel plating, NPT screw type.
    c. NPS 3 and Larger: Class 125 iron body, bronze trim ,flanged ends.
    d. Furnished with a stainless steel ball and stem and fiberglass reinforced Teflon or EPDM seats and seals.
    e. The valves shall have an ISO type 4-bolt flange for mounting actuator in any orientation parallel or perpendicular to the pipe. A non-metallic thermal isolation adaptor shall separate the flange from the actuator.
    f. The isolation adaptor shall also provide stable direct coupled mechanical connection between the valve body and actuator and prevent lateral or rotational forces from affecting the stem and its packing O-rings.

6. Pressure Independent Control Valves

    a. At the Contractor's option, pressure independent two way control valves (PICV) can be used for hydronic systems where sizing permits.
    b. Valve design maybe mechanical or electrical type, unless indicated otherwise. Mechanical type shall utilize an integral pressure regulator across the control valve to allow flow reading from control valve position. Electronic type shall utilize a flow meter in series with control valve with controllers to read and regulate flow.
    c. Forged brass body with nickel plating, NPT screw type.
    d. Furnished with a stainless steel ball and stem and fiberglass reinforced Teflon or EPDM seats and seals.
    e. The valves shall have an ISO type 4-bolt flange for mounting actuator in any orientation parallel or perpendicular to the pipe. A non-metallic thermal isolation adaptor shall separate the flange from the actuator.
    f. The isolation adaptor shall also provide stable direct coupled mechanical connection between the valve body and actuator and prevent lateral or rotational forces from affecting the stem and its packing O-rings.
    g. Integral Pressure Regulator: Located upstream of ball to regulate pressure, to maintain a constant pressure differential while operating within a pressure

differential range of **5 to 50 psig**. Two internal P/T ports shall be incorporated for differential pressure verification.

h. Accuracy: The valve shall reposition to maintain the required flow with a +/- 5% accuracy over full operating pressure differential range.

2.17 CONTROL CABLE

A. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."

PART 3 - EXECUTION

3.1 GENERAL

A. Install all control equipment and wiring in a neat and workmanlike manner to the satisfaction of the Architect and/or Engineer.

B. All immersion wells, pressure tappings and any associated shutoff cocks, flow switches, level switches and other such items furnished by the control manufacturer shall be installed by the mechanical contractor under the coordinating control and supervision of the control contractor.

C. Install all control devices in a location accessible to maintenance personnel. For example: above a lay-in ceiling and not a hard ceiling, actuators facing downward or sideways in congested areas, valves near floor level instead of at high points, etc.

D. Provide, install, calibrate and demonstrate to the owner a complete and functioning control system per the specified sequence of operations and commissioning requirements.

E. All wiring required for a full and functioning control system per the sequence of operations is work of this section.

F. All control panels and monitors shall be provided, installed where shown on plans or detailed within the specifications and powered by the control system manufacturer/installer. Control panels provided to locations other than shown shall be provided, installed and powered by the control system manufacturer/installer. The controls contractor is to provide ample power wiring to power all panels from Power Panels as designated.

1. Control panels for the rooftop air handlers shall be located at a location approved by the Architect/Engineer.
2. Control panels for the indoor air handlers shall be located within the same room as the air handler.

G. Provide and install all devices and wiring between HVAC manufacturer's factory installed equipment and all remotely mounted equipment such as flow switches and, data gathering cabinets and miscellaneous equipment for a complete and operating system.

H. All terminations made within the control manufacturer/ installers panels shall be verified and tested prior to final powering of panel. Control devices from other systems shall not be temporarily or permanently mounted within the control panel.

I. Electrical Wiring:

1. All electrical wiring for the control system, including power circuit to control panels, both line and low voltage unless otherwise indicated, shall be furnished and installed by the control contractor in metal conduit and in accordance with all the electrical sections of this specification and all applicable electrical codes. This is in addition to power indicated on Division 26 drawings for control panels for air handling units and other pieces of mechanical equipment.
2. Control panels serving equipment fed by emergency power shall be fed by emergency power. Coordinate all requirements with the Division 26 contractor.

J. Electrical Work:

1. Control Wiring: Control wiring shall be provided as a part of this specification section. Run all control wiring separate from power wiring, also do not utilize the same conduit for analog sensor wiring and any wiring carrying an AC current. Install wiring in accordance with the National Electric Code, and applicable local codes. All wire and wiring devices used shall be certified by the temperature controls subcontractor.
2. Power Wiring: Power wiring to all DDC panels, VAV box controllers, and additional control devices as required, shall be provided as part of this work. Power circuits to DDC panels shall not be shared with any other electrical equipment. Power wiring required by the control manufacturer/installer for electric end devices (eg: actuators, relays, etc.) is work of this section. All conduit, wire, hangers, etc. associated with wiring to end devices is work of this section.
3. All EMT shall be a minimum of 3/4" in diameter. Steel compression fitting shall be used to join EMT with electrical boxes, cabinets and panels.

K. Test And Balance And Commissioning:

1. The Contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance and commissioning purposes.
2. The Contractor shall provide training in the use of these tools. This training will be planned for a minimum of 4 hours.
3. In addition, the Contractor shall provide a qualified technician to assist in the test and balance and commissioning process.
4. The tools used during the test and balance and commissioning process will be returned at the completion of the testing and balancing and commissioning.

L. Work By Others:

1. All valves and dampers shall be installed by the mechanical contractor. All pipe and duct penetrations shall be provided by the mechanical contractor, or his designated subcontractor.

M. Valves:

1. All temperature control valves, furnished by the control manufacturers shall be installed by the mechanical contractor under the coordinating control and supervision of the control contractor.
2. Valve submittals shall be coordinated for type, quantity, size and piping configuration to ensure compatibility with pipe design.
3. Slip-stem control valves shall be installed so that the stem position is not more than 60 degrees from the vertical up position. Ball type control valves shall be installed with the stem in the horizontal position.
4. Valves shall be installed in accordance with the manufacturer's recommendations. Installation in a horizontal pipe run is preferred.
5. Control valves shall be installed so that they are accessible and serviceable and so that actuators may be serviced and removed without interference from structure or other pipes and/or equipment.
6. Unions shall be installed at all connections to screw-type control valves.
7. Provide tags for all control valves indicating service and number. Match identification numbers as shown on approved controls shop drawings.
8. Provide pressure independent control two way valves as specified or when indicated. Balance valves or automatic flow control valves are not to be utilized in series with PICVs.

3.2 EXAMINATION

A. Verify that conditioned power supply is available to control units.

3.3 INSTALLATION

A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

B. Connect and configure equipment and software to achieve sequence of operation specified.

C. Controllers:

1. Install local application specific controllers where indicated on the plans or suitable location adjacent to the system served. Mount panel on wall with suitable brackets. Co-ordinate controller locations with other trades.

D. Space Sensors:

1. Verify location of thermostats, humidistats, and other exposed control sensors with drawings, room details and Architect before installation. Install devices 48 inches above the floor to the top of the device.

   a. Any room thermostats/temperature sensors mounted on exterior walls shall be mounted on thermally insulated sub-base.
   b. Relocate room thermostats/temperature sensors if required due to draft, interferences with cabinets, artwork, furniture, etc., or improper sensing.

2. Install guards on adjustable thermostats (not space sensors) in the following locations:

   a. Entrances.
   b. Public areas.
   c. Where indicated.

E. Duct/Piping Sensors:

1. Install duct pressure, temperature or humidity sensors where indicated or directed to meet job site conditions.
2. Mount all sensors per manufacturer's requirements.
3. Relocate duct sensors if required due to improper sensing.
4. Mount averaging sensors with serpentine sensing element across the entire area of the medium being sensed. Install sensors at accessible locations with suitable mounting brackets and element duct collars where required.
5. Install piping sensors on top of piping. Insulate duct and pipe sensors to prevent condensation of cold surfaces.
6. Provide matched temperature sensors for chilled and hot water differential temperature measurement. Differential accuracy shall be within 0.2° F.
7. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
8. For immersion sensors with wells, install thermal grease in well to improve conductivity.

F. Install automatic dampers according to "Air Duct Accessories."

G. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

H. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."

I. Install labels on temperature and humidity sensors indicating the controlled device or equipment. Coordinate label style and location (e.g. Kroy/P-Touch tape, color coded dots, etc.) with architect and owner. Locate label on back of sensor cover where possible.

J. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."

K. Air Terminal Units:

1. Provide controllers to air terminal unit manufacturer for factory mounting.
2. Assemble and install connections, tubing, and accessories between air terminal elements , controller and actuators as prescribed by manufacturer's written instructions.
3. Field calibrate air terminal units with test and balance readings of airflow.

3.4 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling."

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Install exposed cable in raceway.
3. Install concealed cable in raceway.
4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

C. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

D. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
2. Test and adjust controls and safeties.

3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
4. Test each point through its full operating range to verify that safety and operating control set points are as required.
5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
6. Test each system for compliance with sequence of operation.
7. Test software and hardware interlocks.

C. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check instrument tubing for proper fittings, slope, material, and support.
5. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
6. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
7. Check temperature instruments and material and length of sensing elements.
8. Check control valves. Verify that they are in correct direction.
9. Check DDC system as follows:

   a. Verify that DDC controller power supply is from emergency power supply, if applicable.
   b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
   c. Verify that spare I/O capacity has been provided.
   d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.6 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:

a. Check analog inputs at 0, 50, and 100 percent of span.
b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
c. Check digital inputs using jumper wire.
d. Check digital outputs using ohmmeter to test for contact making or breaking.
e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

5. Flow:

a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
b. Manually operate flow switches to verify that they make or break contact.
c. Calibrate meters according to manufacturer's written instructions, after installation.

6. Pressure:

a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

7. Temperature:

a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
b. Calibrate temperature switches to make or break contacts.

8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
10. Provide diagnostic and test instruments for calibration and adjustment of system.
11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01 Section "Demonstration and Training."

1. Upon completion of the work and acceptance by the Owner, the installing Contractor shall provide installation/operation information to the Owner's operating personnel who have responsibility for the mechanical system. The contractor shall provide telephone support to the owner's operating staff for a period of one year for no additional cost.
2. Contractor shall provide ten (10) hours of training, in blocks of 4 hours, during normal business hours to a minimum of two (2) owner's representatives designated by the facility. Training subjects and format shall be subject to the Owner's approval. Training shall be digitally recorded by the Controls, to be handed over the facility for future use.

B. HARDWARE SUPPORT

1. The manufacturer of the DDC system shall provide assistance in product applications and system trouble shooting. The materials and installation shall be guaranteed to be free of defects for one (1) year from date of beneficial use.

3.8 SYSTEM ACCEPTANCE

A. Upon completion of the project, the Building Automation System contractor shall:

1. Completely adjust or calibrate all devices provided under this section.
2. Provide testing and adjustment of the complete system as required per code or specification. Validate system points from the Personal Computer Operator Workstations to the field points.
3. Test connected devices so that the displayed controlled variable is within plus or minus 2% of the actual sampled variable.
4. Test remote access capabilities of the system including verifying remote alarm functionality.
5. Participate and support commissioning efforts

B. The installing Contractor shall issue a report upon project completion stating that the system has been completed and adjusted has had all hardware and software functions verified, and is operating in accordance with the specifications. Any deviations from specified settings or operations necessitated during system adjustment shall be specifically noted. A demonstration of complete system operation shall be made to the Owner's representative.

END OF SECTION

SECTION 23 09 93 – CONTROL SEQUENCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including general and supplementary conditions and Division 01 specifications, apply to this section.

PART 2 - PRODUCTS

2.1 GENERAL

A. Refer to Division 23 Section “Instrumentation and Control for HVAC” or Division 23 Section “HVAC Controls”.

PART 3 - EXECUTION

3.1 GENERAL

A. This section is a supplement to the control diagrams on the drawings. The control diagrams generally indicate control devices as well as some desired logic. This section provides the basis for the sequences of operations, the control logic, device location clarification, measurements, as well as the general intent of the outcome for the control systems.

B. The Execution section Paragraphs are arranged in an alternate way to improve the clarity of the intent by avoiding duplication and repetition of the requirements common to multiple systems.

C. The abbreviations AFD, ASD, and VFD are used interchangeably and all represent the same adjustable speed drive controller for a motor.

3.2 GENERAL REQUIREMENTS FOR ALL SYSTEMS:

A. CONTROLLER POWER: The power for equipment control panels shall be powered from the line side of the starter for the equipment controlled or from a separate circuit (by Div. 23) so that the controller will continue to have power and will stay on the BAS network when the unit is turned off or is off due to failure.

B. EMERGENCY POWER: If the equipment being controlled is on emergency power, then the controller must be on emergency power also.

C. CONTROL DEVICE POWER: The basis for control and monitoring of all actuators and control devices is to use low voltage 24V power. The controls contractor shall provide low voltage wiring for all controls. Since different controls contractors would execute the control wiring in different ways, the project documents do not include locations for source 120V power to feed the 24V power wiring – that task shall be the responsibility of the successful controls contractor. The controls contractor shall coordinate with the electrical contractor and compensate the electrical contractor for desired quantities and locations for 120V power sources to feed their low voltage system design.

D. 24V DAMPER AND VALVE ACTUATORS: The basis of design is for 24V low voltage actuators for all air-side dampers and water side valve actuators. The intent is for the controls contractor to have exclusive responsibility for installation and operation of all control systems – including the smoke and fire-smoke dampers.

E. SMOKE AND FIRE SMOKE-DAMPER ACTUATORS: The basis of design is for 120V smoke and fire-smoke damper actuators. Since 24V has wire length voltage drop limitations for long runs, 120V has been designed. The contractor may substitute 24V smoke and fire smoke damper actuators as a pre-approved substitute including a credit from Div. 26 for not providing 120V wiring.

F. SCHEDULES: The schedules shall be based upon a 24-hour, 365-day calendar with exception days and holidays.

1. For multi building facilities provide four levels of scheduling. They shall be Area, Group, Building, and Unit. Units will be assigned into buildings, buildings into groups, and groups into areas. Each piece of equipment shall reference all these schedules and if any of them are occupied, the equipment shall go into occupied mode.

G. ACTIVE SET POINTS: The control sequences shall reference active cooling and heating analog values. These values shall be set to the occupied set points during occupied mode and the unoccupied set points in unoccupied mode.

H. PRE/POST OCCUPANCY MODES: Each piece of equipment and system shall have pre and post occupancy variables to indicate how many hours before and after occupancy the equipment shall operate in pre/post occupancy mode. In pre/post occupancy mode, the equipment shall use occupied set points but shall use either no outside air or alternate ventilation rates.

I. ACTUATOR FEEDBACK: Provide BAS monitoring of position feedback of valve and damper actuators. The purpose for this requirement is for user identification of malfunctioning actuators at the BAS front end graphic screens, and to assist in commissioning, and to reduce the troubleshooting time schedule. End switches are not an acceptable method of monitoring partial positions. An actuator feedback alarm shall be generated if the position feedback differs from the commanded position by more than 15% for 5 minutes. Graphic points shall include the following for each actuator:

a. Commanded Position.

b. Position Feedback.
c. Feedback Alarm

J. PID LOOP TUNING: It is expected that the controls technicians shall provide PID loop tuning for the various controlled systems to avoid overshooting and oscillation. At the minimum Proportional gain and the Integral time values shall be adjusted based upon device manufacturers recommendations, and the control technicians shall be able to discuss their P and I values with the engineer and commissioning authority. Common P&I values can be used for similar groups of devices (such as all supply VFD's or all 2-way HW control valves, etc.). Derivative time shall be 0 or off for most HVAC control loops. Only high reaction speed control loops, such as in laboratories and clean rooms, shall include D values. Small reheat valves are particularly subject to hunting, so loop tuning shall be included for those devices.

K. VARIABLE FREQUENCY/ADJUSTABLE SPEED DRIVE CONTROL AND MONITORING: The basic specification for VFD equipment requires a CAT 5 connection to the control system. The controls contractor shall incorporate the VFD's manufacturer's data format to at least display the internal set-up values (generally in the range of 50-100 data points) and operating values if the operator chooses to observe the operation of a VFD on a separate graphics/data screen. The basic VFD operating data described in subsequent sections shall be provided on the related equipment graphics screen. Providing the operator the ability to quickly evaluate and troubleshoot a VFD and related motor from the BAS front-end is a high value feature since improperly operating VFD's can waste large amounts of unnecessary energy, and of course comfort complaints.

L. ALARM PRIORITY: The BAS shall provide alarms in a logical manner to assist the facility operator in prioritizing alarms. Alarm tags shall include the point name, general equipment name, priority level, and alarm description. For example: KRMC:P07:AHU07_CCTEMP, AHU-7 Cooling Coil Temperature Sensor, Medium Priority, High leaving air temperature 5F above set point. Prioritize alarms based upon the following criteria. Submit alarm priority to engineer for review.

High Priority – equipment failure, freezing, overheating, etc.
Low Priority – high/low temperatures, pressures, dirty filters, diagnostics, etc.

M. Provide function to delete all alarms from the print queue manually if desired. Provide function to sort alarms by priority and print alarms by priority. Provide a graphic page to view both priority alarms. Provide a local error message link in the lower corner of the graphic display of the AHU to display just error messages associated with the pieces of equipment displayed in the graphic page.

High Priority Alarm List. Provide a link to display the last 10 high priority alarm messages associated with the piece of equipment.
Low Priority Alarm List. Provide a link to display the last 10 low priority error messages.

N. CURRENT TRANSDUCER (CT) PROGRAMMING LOGIC: All new constant speed fan motors and pumps shall have analog current transducers (CT) which provide a continuous amp draw signal. The normal amp draw for each constant speed motor shall be recorded and

stored AFTER test and balancing is complete. Program a high limit alarm when current is 25% higher than "normal" for 5 minutes. Program a low limit alarm when current is 50% of "normal" for 5 minutes. The low limit shall be used for proof of flow. If amp draw is below low limit then either flow is very low, or a fan belt broke.

O. PREDICTIVE MAINTENANCE TRENDING GRAPH: For all fixed speed motors with analog current transducers, continuously calculate a 30-day average of motor amp draw (record amp draw only when motor is on). Compare the actual motor amp draw with the 30-day average. If the actual amp draw is 10% higher (adjustable) than the 30-day trailing average, then provide a low-level alarm for "high motor amp draw – anticipate failure". A high amp draw is a prediction of motor or bearing failure.

P. EMERGENCY POWER SOURCE. If only selected equipment and systems are to run on emergency power, then the power source for those control devices shall originate from emergency power.

3.3 GRAPHIC DISPLAYS AT OPERATOR INTERFACE

A. Create graphical display pages for the equipment and systems on the project, including but not limited to the following. Refer to other paragraphs for specific requirements for data points.

1. Air handling/Rooftop units
2. Hot water heating systems
3. CV and Dual Duct mixing boxes summary table
4. Reheat coil summary table
5. Air filter summary table
6. VRF units
7. Supply and exhaust fans

B. Provide floor plan graphic screens which represent the location of the equipment, for click-through of that equipment.

C. Floor plans shall also include data points for space temperature setpoints and measured values. Each room on the floorplan shall be mapped to a color-coded reference chart which displays the measured room temperature in color. There shall be two color coded temperature maps for the floorplans – the first for measured temperature, and the second for difference between the temperature setpoint and the measured temperature. The color code shall be darker blue for cooler rooms, yellow for comfortable rooms, and orange/red for progressively warmer rooms. The same color scheme of shades of blue for colder rooms and shades of red for warmer rooms shall be used for the differential temperature map of the difference between setpoint and actual measurement temperature.

D. Provide a link on each graphic page to the written sequence of operations for that system or piece of equipment.

E. Provide a time/date stamp on the graphic display so it will be shown when captured and printed.

F. Provide a graphical representation for each piece of equipment controlled. Display all sensor points in appropriate locations to the actual placement of the sensors. Provide on/off/position indications for motors, actuators, etc. Display the set points for various control loops adjacent to the actual sensor readings, such as supply air temperature set point and actual temperature, pre-heat coil temperature set point and actual temperature, etc. If the control loop is 'off', such as pre-heating, then show 'off' in the set point display box. Provide a direct link to a floor plan of the building with the area served by the AHU highlighted. Provide a direct link to the Filter Status page.

G. For each piece of equipment, provide a photo-link to a digital photo (or multiple photos for larger pieces of equipment) of the piece of equipment shown in the graphical display.

H. Provide a "Maintenance" screen link to each piece of equipment and system which allows the Owner to input and manage maintenance related items for each piece of equipment. The Maintenance screen shall include data fields for the owner to input make/model numbers for items such as fan belts, motor sizes, filter sizes and quantities, oil type, etc., as well as date field for recording servicing dates.

I. The graphic screen development for equipment and systems shall include displayed data points for the values listed in the various paragraphs. When a particular equipment graphic screen gets too cluttered, it is acceptable that a second page be utilized for the displaying of the non-critical (but still required and desired) data points. In all cases where there is a setpoint variable used in a control algorithm, the associated measured value shall also be displayed to provide the operator with a visual indication of the accuracy of the PID control loop operation.

3.4 PACKAGED EQUIPMENT CONTROLS INTERFACE

A. It is common for project equipment from manufacturers to have self-contained controls and microprocessor logic such as packaged roof top units, container type humidifiers, some VAV boxes, chillers, etc. The self-contained equipment's controls shall be 'connected' and integrated into the overall control system for the project. Internal data points related to operation shall be pulled from the self-contained control system so that the operator can view operating data points at the BAS workstation. And key adjustable operating setpoints such as temperatures and pressures shall be able to be input into the self-contained equipment's control system.

B. If equipment substitutions are made, then the equipment's self-contained control package shall include the control logic and sequence capabilities described in the subsequent paragraphs. Not all features will be available from all manufacturers, which means the controls contractor may have to provide supplementary control logic on stand-alone controllers to meet the sequence of operations design intent.

3.5 GLOBAL AND LOCAL CONTROL

A. The local control system is defined as the hardware and software for a piece of equipment or a sub-system to operate properly. For example, an air handling unit and associated remote temperature sensors, and static pressure sensors is considered a local control system.

B. The global control system is the overall network which connects the local control systems together and connects them with a master controller with global oversight.

C. The local control systems shall be installed and set-up to operate properly in both stand-alone mode as well as normally connected to the global control system. During system commissioning, stand-alone operation shall be validated by disconnecting the global network connection and observing the equipment operating normally – or in a special stand-alone mode if specified.

D. If no stand-alone mode is specified, then the stand-alone mode for the equipment/system shall be the current mode of operation when the global network connection as lost.

3.6 AIR SIDE SYSTEM AND EQUIPMENT BASIC CONTROL REQUIREMENTS

A. General Requirements. The following basic features shall be included for every air handling unit, blower coil unit, and fan-coil units. These basic items are not duplicated in subsequent sections. For units without a specific device or mode, such as no heating capability, then that mode is obviously not required.

1. START/STOP. Each air handler and controls shall be enabled / disabled by the BAS. Unit controls shall operate automatically when energized.
2. NORMALLY ON/OFF. The normally OFF (disabled) status shall be: fans off, smoke dampers closed, return air damper open, outside air damper closed, chilled water valve closed, hot water valve closed. The normally ON status shall be: fans on and outside air dampers enabled, chilled and hot water valves enabled.
3. OUTDOOR AIR DAMPER ACTUATORS: All outdoor air damper actuators shall be modulating type spring return CLOSED, so they will close automatically on loss of utility or control power. 100% outdoor air units can have 2-position damper actuators, with spring return closed.
4. MINIMUM OA. The outside air volume shall be set up (with TAB) as a minimum damper position during occupied periods - along with active means of controlling the OA volume in VAV systems according to ASHRAE 62 or Title 24 requirements.
5. FIRE ALARM SHUTDOWN RELAY: A relay from the fire alarm system shall initiate a contactor in the AHU fan starter or VFD which turns off the AHU fans upon an alarm signal from the fire alarm system.
6. DUCT SMOKE DETECTORS: The Electrical division shall provide duct smoke detectors (compatible with their fire alarm system) for installation by the Mechanical. The fire alarm contractor shall be responsible to wire the devices to the fire alarm system.

7. INTERCONNECTS: Associated exhaust and supply fans shall be started and stopped through control power from the load side transformer for their respective air handling systems. If supply fan fails proof of flow, then the associated exhaust fans shall turn off, and zone smoke dampers shall lose power and spring closed.
8. OCCUPIED MODE: Provide an Occupied mode of operation for each unit. During the Occupied mode, the unit shall operate according to the listed sequences of operation, but generally the outside air damper shall be open to provide minimum outdoor ventilation and the active set points shall be set to the occupied set points. The AHU supply fans shall operate continuously in occupied mode.
9. UNOCCUPIED MODE: Provide an Unoccupied mode of operation for each AHU. In general, the outside air damper shall be closed, and the active set points shall be set to the unoccupied set points. When the space temperatures exceed the unoccupied high and low limits, then the AHU shall be enabled (with the OA damper closed) until the space temperatures are met. The AHU supply fan shall not run during deadband mode between the high and low temperature limits. The unoccupied high space temperature limit shall be initially set to 80F, and the low limit set to 60F. The outside air damper may open during unoccupied mode if economizer cooling is possible.
10. HEATING MODE: When the space temperature falls below the active heating set point, the controller shall enable the heating sequence. Once the temperature rises above the setpoint plus the deadband (2 degrees (ADJ)) then the unit will enter deadband mode.
11. COOLING MODE: When the space temperature rises above the cooling set point, the controller shall sequence the stages of cooling to maintain space temperature set point. Once the temperature falls below the setpoint minus the deadband (2 degrees (ADJ)) then the unit will enter deadband mode.
12. DEADBAND MODE: In deadband mode, between a high and low setpoint, neither heating nor cooling shall be enabled.
13. PRE-HEAT RESET. The pre-heat coil leaving air temperature setpoint shall be a derived value of the main unit Supply (not coil leaving) air temperature low limit setpoint (usually 54F or 55F) minus 5F. The intent is to provide a deadband between heating and cooling coil temperatures to avoid simultaneous operation, and to account for some fan reheat.
14. DEHUMIDIFICATION MODE: When the space humidity exceeds the high humidity set point of 60%, then the unit shall enter dehumidification mode – which is basically suspending the supply air reset schedule and returning the supply air setpoint back to the base value. The unit shall remain in dehumidification mode for an adjustable period, starting at 30 minutes.
15. MINIMUM OUTSIDE AIR VOLUME SETPOINT: Every AHU shall have the OA damper configured for a specific position for minimum OA ventilation air. The TAB contractor shall assist in verifying airflows and damper positions.

3.7 GENERAL AIR HANDLING UNIT CONTROL SEQUENCES

A. This section describes the requirements and sequences for the various components used on air handling units. Refer to the control diagrams for the layout of the various components and the related control sequences.

B. GRAPHICS. The main graphics page for the air handling units shall include all physical equipment, virtual modes of operation, variable values, etc. Remote system data shall be pulled in and displayed along with local alarms including the following:

1. Outside air temperature from remote sensor if necessary
2. Outside air humidity from remote sensor if necessary
3. Mixed air temperature
4. Local alarms: low temperature, equipment failure, high pressure, etc.

C. RETURN AND EXHAUST FAN GRAPHICS. The speed control method is listed in another paragraph. Provide the following additional control connections: binary input for VFD alarm, analog input for VFD speed monitoring, analog input for VFD kW power consumption. The kW power consumption shall be used for proof of flow. Graphic Points:

1. Fan Start/Stop
2. VFD commanded speed
3. VFD speed feedback
4. VFD status
5. Amps/kW – Bar graph with marks identifying normal with new and loaded filters
6. Minimum RF Amps
7. Fan Proof of flow – Graphic showing fan rotating
8. Static Pressure
9. Static Pressure Set Point (Adjustable)

D. AHU COIL TEMPERATURE RESET. The main supply air temperature setpoint (leaving the AHU, not the coil) shall be the controlling temperature for heating and cooling coils in the AHU. The coil leaving temperature sensors are generally for monitoring, not necessarily control. The main supply air temperature sensor and setpoint (generally called T1 on the control diagrams) shall be used to provide control input to the coil logic. For draw-through AHU's, the cooling coil leaving air temperature scheduled on the drawings includes provisions for a few degrees of supply fan heat. So a desired 55F supply air temperature is generally achieved with a leaving cooling coil temperature of 51-53F, and the sensors shall be configured to show that operation.

E. SIMULTANEOUS HEATING AND COOLING CONTROL. In most modes of operation, simultaneous heating and cooling is not necessary. It may be necessary in certain modes such as high-humidity control mode, or precision environmental control such as laboratories. Include control logic, or appropriate temperature setpoint offsets to prevent unnecessary simultaneous heating and cooling.

F. DX COOLING. The DX capacity shall be staged (or modulated) by the supply air temperature logic of the air handling unit. When the supply air temperature is above the set point, the cooling stages shall increase to maintain the set point. Calculate the cooling stages capacity to affect the air temperature (typically +/-5F) and include an offset in the supply air temperature reset schedule to prevent short cycling. The supply air temperature set point will vary based upon reset schedule. If the packaged controller does not have supply air temperature reset capability, then the controls contractor shall provide a separate control device to reset the packaged unit's supply air temperature

setpoint. If the cooling coils have split-face coils, then the controls contractor may have to modify the packaged control sequence to ensure both coil sections are always on (to prevent unconditioned bypass air) or add a face/bypass damper to the lag coils. In no circumstances shall air be allowed to flow through an 'off' coil section. Graphic Points:

1. Cooling Coil Leaving Air Temp
2. Cooling Coil temperature setpoint (reset)
3. Pre-treated outside air temperature if applicable.
4. Supply Air Temperature
5. Supply Air Temperature Set Point
6. Cooling stages/capacity commanded position
7. Cooling stages/capacity operating

G. FILTER PRESSURE MONITORING: Provide differential pressure sensors (not switches) for all individual filter sections, pre and final. Observe and set clean filter pressure drop setpoint during startup (with clean filters). The dirty setpoint shall be initially set to 2x the clean setpoint – or as otherwise listed in the equipment schedule, or as directed by the engineer. Both clean and dirty values shall be a displayed in the AHU graphic screen. Dirty setpoints shall not exceed the manufacturer's maximum pressure rating for the filters. For guidance, pre-filters usually shall not exceed 0.45" (the frames will collapse), and 90%-99% filters usually shall not exceed 1.3". Refer to the Filter Status Programming paragraph for more information.

1. Graphic Points:

   a. Current Filter Pressure Drop for Each Bank
   b. Dirty Limit for Each Bank
   c. Dirty Filter Alarm for Each Bank

2. Substitution requirement for DP Switches: If a post-bid cost cutting substitution of DP switches is proposed in lieu of DP sensors, then the following setup labor and costs shall be included in the substitution scope of work:

   a. Field measurement of clean filter pressure drop. Calculation of 2x clean pressure drop for dirty pressure drop, in lieu of specific direction found in equipment schedules.
   b. Manual set-up of pressure switch 'dirty' pressure setting using a Magnehelic gauge.
   c. Hand-write with a permanent marker the pressure value (e.g. 0.45 in. w.g.) that the switch contact closure was set to on or nearby the physical switch itself.

H. TERMINAL HW REHEAT COILS. Associated downstream duct reheat coils shall be interlocked with air handler to energize reheat controls with air handler operation. Reset the supply air temperature set point to maintain space temperature. Modulate the hot water valve to maintain supply air temperature set point. Provide room sensors with occupant set point adjustment for reheat coils and limit adjustment from 66°F to 74° F. (note low temperature setting on reheat system actually saves energy because reheating is

minimized). Supply air temperature set point information is utilized by the air handler controller for discharge air temperature control.

1. Graphic Points:

   a. HW Valve position
   b. Space temperature
   c. Space temperature set point
   d. Supply air temperature
   e. HW supply temperature (from Boiler Plant)
   f. HW supply set point (from Boiler Plant)

2. "Special Space" Terminal Reheat Cascade Control

   a. Cascade control shall be used for special spaces requiring precise temperature control including: Operating rooms, IT/server rooms, animal rooms, etc.
   b. Provide a wall temperature adjustment device, with the remote temperature sensor located downstream of the reheat coil in the supply duct. The close proximity of the sensor to the reheat coil serves to reduce reaction time and reduce valve hunting.

I. TERMINAL OR DUCT ELECTRIC REHEAT COILS. Associated downstream duct reheat coils shall be interlocked with air handler to energize reheat controls with air handler operation. Stage the electric heat to maintain space temperature at setpoint. Provide room sensors with occupant set point adjustment for reheat coils and limit adjustment from 66°F to 74° F. (note – a lower low temperature setting on reheat system actually saves energy because reheating is minimized).

1. Graphic Points:

   a. Space temperature
   b. Space temperature set point
   c. Leaving air temperature
   d. Stage or capacity of heat energized

2. "Special Space" Terminal Reheat Cascade Control

   a. Cascade control shall be used for special spaces requiring precise temperature control including: Operating rooms, IT/server rooms, animal rooms, etc.
   b. Provide a wall temperature adjustment device, with the remote temperature sensor located downstream of the reheat coil in the supply duct. The close proximity of the sensor to the reheat coil serves to reduce reaction time and reduce valve hunting.

J. CAV TERMINALS WITH REHEAT COIL. Associated downstream CAV terminals with reheat coils shall be interlocked with air handler to energize terminal box controller with air handler operation. Modulate the terminal box damper to maintain space temperature set point. Heating coil shall modulate to maintain space temperature set point. Provide room

sensors with occupant set point adjustment and limit adjustment from 66°F to 74°F. VAV damper position, space temperature and set point information is utilized by the air handler controller for discharge air temperature control and static pressure set point. Graphic Points:

1. Heating or Cooling Mode
2. Space Temperature
3. Space Temperature Set Point
4. CAV Box Supply Air Flow (CFM)
5. CAV Box Damper Position (percent open)
6. Space Humidity (as applicable)

K. SUPPLY AIR TEMPERATURE RESET – TERMINAL BOX REHEAT. Provide supply air temperature reset logic control. The design supply air temperature (leaving the unit) shall be 55°F (unless directed otherwise). The reheat coils (Elec or HW) will use cascade control which will calculate the desired leaving temperature from the reheat coil, and the leaving device temperature shall be recorded. The AHU supply air set point shall be reset upwards when all of the reheat boxes are calling for some reheat. The AHU supply air set point shall be reset up to the minimum reheat coil set point for the reheat coils served by this air handling unit. The downstream terminal units shall be polled to see whether any is near full cooling. If none are in full cooling, then the supply air temperature setpoint can be raised 0.5F degree. After a 5-minute delay, the downstream terminal units shall be polled again. If one is in full cooling, then lower the supply air temperature 0.5F. If none are in full cooling, then raise the supply air temperature up 0.5F. The design supply air temperature shall be 55°F (unless scheduled otherwise) on startup and shall be reset based upon terminal unit demand. Any space or return air humidity sensor shall override supply air reset for 30 minutes (adjustable) when the space humidity rises above the adjustable high limit set point 60% RH. Provide a reheat coil table graphics screen. Provide a check box in the reheat coil table to allow the user to include/exclude coils in the reset schedule calculation logic. Graphic Points:

1. Minimum associated reheat leaving air temperature set point enabled for control
2. Minimum associated reheat leaving air temperature set point.
3. Supply Air temperature set point. (max of 62F, min of scheduled cooling coil LAT + 2F)
4. Supply air temperature.

L. HOT WATER RE-HEAT COIL. The re-heating coil control valve shall have a setpoint which can be modulated by the supply air temperature logic of the air handling unit, or by a space temperature sensor if it is a single zone unit. The re-heat coil discharge temperature setpoint shall be reset by the supply air temperature reset logic. (if the re-heat coil is the last process, then the re-heat temperature and the supply air temperature values would be the same) The re-heat temperature setpoint shall then be adjusted up or down based upon the supply air temperature reset logic (or space sensor). There may be a high humidity limiting control logic mode which over-cools for moisture removal – in that mode the re-heat coil would be enabled to operate normally by the supply air temperature setpoint (to prevent overcooling). The user shall not have to adjust the re-heat setpoint, it shall be managed entirely by the offset from the supply air reset logic, or the space setpoint. In

ECONOMIZER mode, the re-heat coil shall be Off. The HW reheat Return Temperature sensor leaving the coil is one of the most valuable points used for verifying proper operation, and for troubleshooting problems – it shall not be eliminated in post-bid cost reduction exercises. Graphic Points:

1. HW Re Heat Coil Leaving Air Temp
2. HW Re-heat coil temperature setpoint (reset)
3. Space temperature (if single zone unit).
4. Supply Air Temperature (can serve as reheat coil discharge sensor too if it the last device)
5. Supply Air Temperature Set Point
6. HW Valve commanded position
7. HW Valve Feedback
8. HW Valve Feedback Alarm
9. HW Return Temperature (leaving the coil)
10. HW Supply Temperature (from Boiler Plant)
11. HW Supply Set Point (from Boiler Plant)
12. Design HW Delta T

M. ECONOMIZER MODE: Provide control logic to mix the OA and RA to the supply air temperature reset value to minimize mechanical cooling, using a Mixed Air temperature sensor and setpoint reset. A comparative enthalpy switchover logic is generally used to turn on/off the economizer mode. Economizer mode shall be enabled when the OA enthalpy is less than the RA enthalpy. The mixed/return air and OA damper actuators shall operate inversely. As the mixed air temperature drops, the OA damper shall modulate from open to the minimum ventilation position. When the minimum ventilation position is reached, then Economizer mode can be turned Off to allow the pre-heat coil to operate normally. Relief may or may not be actively controlled. In some arid regions, the contractor may substitute dry bulb temperature comparative enthalpy control methods for review and approval. Ensure the temperature/humidity sensors for the enthalpy controller are in locations with active airstreams to continuously measure differences between the OA and RA conditions. Graphic points:

1. Economizer Mode on/off (based upon comparative enthalpy switchover logic)
2. Economizer enthalpy temperature values if approved for temperature control
3. Mixed Air temperature setpoint, based upon offset from Supply air temperature reset value.

N. OCCUPIED MODE. When indexed to the occupied mode (either automatically, or manually overridden) the supply air fan shall be enabled, and the various components of the AHU shall be enabled. In occupied mode the OA damper shall be enabled Open to bring in ventilation air for the occupants.

   a. Heating Mode – When the space temperature falls below the heating set point, the controller shall sequence the stages of heating to maintain space temperature set point.

b. Cooling Mode – When the space temperature rises above the cooling set point, the controller shall sequence the stages of cooling to maintain space temperature set point.

c. Dehumidification Mode – When the space humidity exceeds the high humidity limit of 60%, then dehumidification model shall be enabled. Dehumidification mode shall operate until the relative humidity drops below 56% or after 30 minutes. There shall be a 10-minute time delay before the system can re-enter dehumidification mode. Dehumidification mode is essentially lowering the cooling coil leaving temperature to its lower design point to remove moisture from the airstream, thereby lowering the space relative humidity. The control logic may include stages of heating to prevent overcooling the space – which drives up the relative humidity even farther.

d. High and Low Occupied Temperature Setpoints. The space setpoints are generally user adjustable within a pre-defined range of temperatures – for normally occupied spaces. Initially limit user adjustability between a low of 72F and a high of 78F. After occupancy, it is expected that some of the sensor's limits will need to be adjusted. For normally unoccupied spaces such as electric rooms, provide a higher high limit of 80F.

O. DEHUMIDIFICATION MODE. When return air (or space) humidity sensor reads above high humidity setpoint of 60% (adjustable, but limited between 55% and 70%, unless specified otherwise for a special space)), then the supply air temperature reset shall be reset back to the design setpoint (typically 55°F), and the supply air temperature reset logic shall be disabled for 30 minutes (adjustable). Graphic Points:

1. Dehumidification mode status.
2. Humidity reading of space and return humidity sensors.
3. Supply Air temperature reset set point.
4. Supply air temperature.
5. Dehumidification mode timer status.
6. High humidity setpoint (limit user adjustability between 60% and 70%)

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P. FIRE ALARM SHUTDOWN. Electrical shall provide an addressable fire alarm shut down relay to be installed in the AHU starter control circuit which shuts down the AHU on a call from the fire alarm system. When the fire alarm system commands the AHU to shut down, associated smoke dampers shall lose power and spring return close, and associated exhaust fans shall turn off.

Q. DUCT SMOKE DETECTORS. Duct smoke detectors compatible with the fire alarm system shall be furnished by Electrical. Install duct smoke detectors in the supply and return duct (prior to any branch ducts) of air handling units with capacity greater than 2,000 cfm, or as required by local code.

R. TRENDING. Set up the following trends for the AHUs. For each trend group, provide trend durations as indicated.

1. Temperature Performance. Daily and Monthly. Store data collected every 30 minutes (adjustable). Ensure data storage device is large enough to handle at least 2 years of data collection.

   a. Outside air temperature
   b. Return air temperature
   c. Mixed air temperature
   d. Return air humidity, or space humidity
   e. Pre-heat coil leaving air temperature
   f. Cooling coil leaving air temperature
   g. Supply air temperature
   h. Supply air temperature reset value

S. ALARMS. Provide low priority alarms for the following items in addition to the standard high and low priority alarms listed in the alarm requirements.

1. 'Low supply duct static pressure.' When the fan is On and the measured supply duct static pressure is more than 0.2" below the setpoint for more than 30 minutes.
2. 'Low chilled water return temperature' when the coil leaving chilled water temperature is below 52°F for more than 30 minutes, and the cooling coil is enabled. (this is a low delta-T prevention alarm)
3. 'High leaving chilled water temperature' when the leaving chilled water temperature is higher than 64°F for more than 30 minutes, and the cooling coil valve is enabled. (this is preventive maintenance alarm that either the coil strainer is clogged, heating is improperly enabled, or the inlet air temperatures are out of bounds)

3.8 DUAL DUCT MIXING BOX

A. Provide hot/cold airflow regulation to meet room temperature set point. Airflow discharge to be maintained constant volume.

3.9 DX CONSTANT VOLUME AHU – WITH SUPPLY FAN VFD & VRF CONDENSER

A. In addition to the Basic and General requirements listed in previous paragraphs, provide the following items specific to this type of operation. This type of unit would have varying internal static pressure loads requiring the supply fan speed to modulate to maintain a constant volume of air. The most common use would be for constant volume AHU's with final filters having pressure differences exceeding one inch of static.

B. PACKAGED VRF COOLING AND HEATING CONTROLS. The intent for this section is for the equipment manufacturer to furnish a controls package with options necessary to meet the controls design intent. The controls contractor is responsible to provide supplemental control devices and logic to meet the controls design intent.

C. OUTSIDE AIR & RETURN AIR DAMPERS: The outside air and return air dampers shall be modulated to maintain the outside air flow rate at the scheduled value during the

occupied periods. The dampers shall actuate separately and not physically linked. On a need for additional outside air, the outside air damper shall open. Once it has reached 100% open, the return air damper shall modulate closed. The return air damper shall not be modulated closed more than 3% to maintain flow over the return air temperature sensors. Graphic Points:

1. Outside Air Damper commanded position
2. Outside Air Damper feedback
3. Return Air Damper commanded position
4. Return Air Damper feedback

D. SUPPLY FAN VFD SPEED CONTROL FOR CONSTANT VOLUME. A duct mounted differential static pressure sensor shall provide the input signal to the VFD to control the fan speed to maintain the duct static pressure setpoint. The purpose of this control is to maintain constant volume as the filters load up over time, and provide an additional static pressure drop on the fan which would otherwise reduce system air volume. Coordinate with TAB contractor to set up and adjust for proper duct static pressure setpoint – using the higher simulated 'dirty' filter pressure drops. The location of the static pressure sensor shall be within 10 feet of the AHU discharge, in a non-turbulent zone (not an elbow), and accessible for calibration and servicing (it does not need to be 2/3 downstream like in a VAV system). Provide the following additional control connections: binary input for VFD alarm, analog input for VFD speed monitoring, analog input for VFD kW power consumption. The kW power consumption shall be used for proof of flow. Graphic Points:

1. Supply Fan Start/Stop
2. VFD commanded speed
3. VFD speed feedback
4. VFD status (alarms, etc.)
5. Amps/kW – Bar graph with marks identifying normal with new and loaded dirty filters
6. Minimum SF Amps (normal with clean filters)
7. Fan Proof of flow – Graphic showing fan rotating
8. Duct Static Pressure
9. Duct Static Pressure Set Point (Adjustable) (0.01 in w.g. accuracy)

E. RETURN FAN SPEED CONTROL FOR CONSTANT VOLUME. Since the system is CV, the static pressure in the return duct shall be kept at a steady setpoint as well. A return duct mounted differential static pressure sensor shall provide the input signal to the VFD to control the fan speed to maintain the duct static pressure setpoint. Coordinate with TAB contractor to set up and adjust for proper duct static pressure setpoint. The location of the static pressure sensor shall be within 10 feet of the return duct inlet, in a non-turbulent zone (not an elbow), and accessible for calibration and servicing. The fan shall be controlled using a duct static pressure sensor.

1. Return Fan Configuration. The return fan shall be on whenever the supply fan is on, and off when the supply fan is off.
2. Exhaust Fan Configuration. The exhaust fan shall be Off during non-economizer mode. The fan shall be On during economizer mode. The static pressure setpoint

shall be equal the static pressure reading during non-economizer mode (with only the supply fan on). This setpoint be achieved either through a one time setup with the TAB contractor, or using an average value of the measured return duct static pressure over time.

3. OA/RA damper position shall be minimum/design OA during non-economizer mode with the Exhaust air damper closed. During economizer mode, the OA/RA dampers shall modulate opposite each other to maintain the target Mixed Air temperature setpoint, while the EA damper is opened to allow relief air to exit the building.

F. ECONOMIZER MODE:

1. Required.

3.10 EXHAUST FANS - GENERAL

A. In addition to the Basic and General requirements listed in previous paragraphs, provide the following items specific to this type of operation.

B. The controller shall initiate an alarm under the following conditions:

1. Exhaust fan failure

C. EXHAUST FANS ASSOCIATED WITH AHU'S: When the intent is for exhaust fans in an AHU zone to balance the outside air volumes, the exhaust fan shall be enabled with the "associated" air handling unit is enabled. When its associated air handling unit is off, the exhaust fan shall be off. The controls requirement is for the exhaust fan starter control circuit to be connected to the associated AHU starter circuit – so when the AHU is turned off (either remotely or manually), then the exhaust fan's control circuit loses power and turns off too.

D. SCHEDULED OPERATION: When the exhaust fan operation is by occupancy schedule, the BAS time of day schedule and occupancy modes shall turn on and off the exhaust fans.

3.11 ISOLATION ROOM CONTROLS

A. GENERAL. The following paragraphs describe control sequences for independent control loops for specialized rooms including isolation rooms.

B. ISOLATION ROOM: Each isolation room shall have an independent graphic screen which shall include all of the control devices and logic associated with the isolation room including exhaust fan and associated points and associated points, pressure monitoring, etc.

C. DP MONITORING: Provide monitoring of the differential pressure between patient isolation room and corridor. Provide a local display indicating the referenced pressures. Provide a local alarm if the differential pressure falls below adjustable set point of .01" WC negative across a door, for an adjustable period of time (1 minute). Provide door contact

switches and connect to alarm device. Refer to the drawings for requirements for vestibule pressure monitoring. An isolation room shall be set up negative to the corridor. This alarm shall also be indicated as a high priority alarm in the BAS. Provide a local alarm silence button with a status to be monitored by the BAS.

D. FAN MONITORING: On the isolation room graphic screen, provide graphics for associated exhaust fan, and filter pressure sensors.

E. The Isolation Room exhaust systems shall operate continuously including operation during fire alarm – to main containment of spaces. The supply side may be allowed to be shut down.

3.12 FILTER STATUS PROGRAMMING

A. Provide static pressure sensor across each pre and final filter section which provides a continuous static pressure signal.

B. Coordinate with mechanical and TAB contractor to determine 'clean' filter drop, and 'dirty' filter drop values as listed by the submitted manufacturer. Typically, the pre-filter clean and dirty pressure drops are 0.3" and 0.6" respectively. Typically, the final filter clean and dirty pressure drops are 0.7" and 1.5" respectively.

C. If the static pressure exceeds the dirty filter pressure limit, then provide an alarm which indicates the specific AHU filter is dirty.

D. Indicate current pressure drops and dirty limit on each AHU and FCU graphic page.

E. Provide a separate graphic page on the new, BAS which is dedicated to filters. Provide a table which indicates all filters for all AHUs, the current pressure drop and the dirty pressure drop, as well as a 'dirty filter' indication for all filters sections that exceed the dirty pressure drop. An example of the table is as follows.

Unit Name	*Location*	*Filter Type*	*Pressure Drop Actual*	*Dirty Limit*	*Dirty?*	*Filter Type and Size*	*Quantity*
AHU-1	Mech Room 1	Pre	Actual Press Drop	0.6"	Yes/No	By mech contractor	By mech contractor
AHU-1	Mech Room 1	Final	Actual Press Drop	1.5"	Yes/No	By mech contractor	By mech contractor
AHU-2	Mech Room 2	Pre	Actual Press Drop	0.6"	Yes/No	By mech contractor	By mech contractor

F. For each air handling unit graphical screen provide a button to access a separate graphical screen containing just reheat coils associated with that air handling unit.

3.13 VRF SYSTEMS

A. The manufacturer of this equipment provides control system integrated into the equipment.

B. Provides communication of points to existing BAS system from VRF system.

END OF SECTION

SECTION 23 21 13 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:

1. Hot-water heating piping.
2. Drain and Vent piping.
3. Safety-valve-inlet and -outlet piping.
4. Condensate drain piping.

B. Related Sections include:

1. Division 23 Section “Seismic Restraint for HVAC”.
2. Division 23 Section “Vibration Controls for HVAC”.
3. Division 23 Section “Hydronic Piping Specialties”.
4. Division 23 Section “General-Duty Valves for Hydronic Piping”.
5. Division 23 Section “Hangers and Supports for HVAC”.

1.3 DEFINITIONS

A. Design Pressure: Minimum required pressure rating requirement at indicated operating temperature of piping systems and associated valves, fittings, and specialties for sustained operation.

B. Maximum System Design Pressure: Maximum sustained operating pressure during normal operating conditions in associated piping systems, typically downstream of the pump.

C. Working Pressure: Maximum sustained operating pressure during normal operating conditions in associated piping systems, typically downstream of the pump.

D. PP-R: Copolymer polypropylene material with random monomers orientation.

E. PP-RCT: Crystalline form of copolymer polypropylene material.

F. SDR: Standard dimension ration where pipe wall thickness is a ratio of the outside dimension.

1.4 PERFORMANCE REQUIREMENTS

A. Products shall be suitable for piping system fluids, materials, pressures, and temperatures.

B. Hydronic piping, components, fittings, specialties, and installation shall withstand the following minimum design pressure and temperature:
   1. Copper Tube: 125 psig at 200 deg F.
   2. Schedule 40 steel Pipe: 125 psig at 200 deg F.
   3. Drain and Vent Piping: Equal to the pressure of the piping system to which it is attached.
   4. Hydronic Fittings, Valves, Meters and Specialties: Equal to the pressure of the piping system to which it is attached.
   5. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

C. Hydronic piping, components, fittings, specialties, and installation shall withstand pressures required by pressure test requirements of these specifications. Pressure test of hot systems and plastic systems to be performed at reduced temperature.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of the following, provide product data for all items including as applicable dimensions, capacities, materials of construction, non-compatible fluids, pressure and temperature ratings, pressure drop and appropriate identification:

   1. Pipe and fittings.
   2. Press fittings.

B. Shop Drawings:

   1. Detail, at 1/8” scale, coordinated piping drawings.
   2. Include details for fabrication of hangers, supports for multiple pipes, pipe anchors and guides, expansion joints, pipe bends and loops, and attachments of the same to the building structure.
   3. Detail location of anchors, alignment guides, and expansion joints and loops.
   4. For preinsulated piping systems, the supplier shall provide the 1/8” coordinated piping drawings. Include for underground piping trenching requirements, pipe insulation, fitting insulation and means to control and accommodate thermal piping expansion.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals. Include special warranty.

1.7 QUALITY ASSURANCE

A. Hydronic piping, specialties and components shall be fabricated and installed to comply with ASME and ASTM Standards.

B. Installer Qualifications:

1. Installers of Press fitting Joints: Installers shall be certified by the press fitting manufacturer as having been trained and qualified to join piping with press fittings.

C. Steel Support Welding: Qualify procedures and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Pipe Welding: Qualify procedures and operators according to ASME standards including Boiler and Pressure Vessel Code: Section IX.

1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

PART 2 - PRODUCTS

2.1 GENERAL

A. Hydronic piping, components, fittings, specialties, and installation shall be suitable for indicated service with design pressure and temperature ratings as indicated in Part 1 “Performance Requirements” Article.

B. Hydronic piping, components, fittings, specialties, and installation shall withstand 1.5 times the system’s working pressure for pressure test requirements.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper (hard) Copper Tubing: ASTM B 88, Type L.

B. Copper and Copper Alloy Fittings: Soldered or brazed joints.

C. Press Fittings, Copper and Copper Alloy Press Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Xpress
b. Merit Brass
c. Viega.

2. Housing: Copper.
3. O-Rings and Pipe Stops: EPDM.
4. Tools: Manufacturer's special tools.
5. Minimum 200-psig working-pressure rating at 250 deg F.

2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe – 2" and smaller: ASTM A 53/A 53M, black steel with plain ends; Grade B, type E electric resistance welded, or Grade A, type F continuously welded, schedule 40.

B. Cast-Iron Threaded Fittings: Classes 125, 250 or higher as required by Part 1 "Performance Requirements" Article.

C. Malleable and ductile Iron Threaded Fittings: Classes 150, 300 or higher as required by Part 1 "Performance Requirements" Article.

D. Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

E. Forged-Steel Flanges and Flanged Fittings: Classes 125, 150 or higher as required by Part 1 "Performance Requirements" article including bolts, nuts, and gaskets.

2.4 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Nonmetallic, flat, asbestos-free, suitable for chemical, thermal and pressure conditions of piping system contents and piping components being joined.

B. Flange Bolts and Nuts: Carbon steel, unless high strength steel is required for high temperatures and pressure.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; or BAg1, silver alloy for joining copper with bronze or steel.

F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.5 TRANSITION FITTINGS

A. Transition fittings for plastic to metallic piping systems shall be provided by the plastic piping manufacturer.

B. Unions: Assembly of steel, copper, copper alloy or plastic to match associated piping systems with neoprene gasket and with threaded, solder-joint, plain, grooved or weld-neck end connections that match piping system materials.

2.6 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with insulating material and with threaded, solder-joint, plain, grooved, fusion weld or weld-neck end connections that match piping system materials

B. Dielectric Unions: Factory-fabricated, union assembly with neoprene gasket.

C. Dielectric Flanges: Factory-fabricated, companion-flange assembly including bolts, nuts, and gaskets.

PART 3 - EXECUTION

3.1 PIPING SCHEDULES

A. Hydronic piping, components, fittings, specialties, and installation shall suitable for indicated service with design pressure and temperature ratings as indicated in Part 1 “Performance Requirements” Article.

B. Fittings, specialties and valves to be compatible with associated piping systems utilizing soldered, brazed, press fittings, grooved, screwed, welded, flanged, solvent cement or fusion welded fittings as indicated in Part 2 specifications.

C. Minimum piping size shall be ¾”. ½” or smaller piping sizes are prohibited.

D. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be any of the following:

1. Copper tubing (hard), copper and copper alloy fittings.
2. Steel pipe; Steel, ductile or malleable iron fittings.

E. Condensate-Drain Piping shall be any of the following:

a. Copper tubing (hard), copper and copper alloy fittings.

F. Specialties, Drain and Vent Piping: Same materials and joining methods as for piping specified for the service in which it is installed.

G. Transition Fittings: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer’s written instructions.

H. Safety Relief Valve and Pressure Relief Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which relief valve is installed.

1. Provide a relief valve in each closed loop system.

3.2 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel or groove plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Plastic piping joints to be made in accordance with the piping and fitting manufacturer's instructions.

D. Copper Pipe Joints:

1. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
2. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
3. Press fitting Joints: In accord with manufacturer's installation instructions. Tubing shall be full inserted into fitting and marked. The fitting alignment checked against the mark to assure the tubing is fully engaged. The joints shall be sealed by pressing tools approved by the manufacturer.

E. Steel Pipe Joints

1. Threaded Joints: Thread pipe with tapered pipe threads according to ASME. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

2. Welded Joints: Weld steel joints according ASME code, ANSI and State codes as applicable, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
3. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

4. Grooved Mechanical Joint: In accord with manufacturer's installation instructions. Cut or roll groove in pipe and remove all cutting residue. Apply joint lubricant to gasket and pipe ends. Install gasket, align pipe ends and gasket, and secure fitting housing.

3.3 PIPING INSTALLATIONS

A. Refer to other Division 23 specifications including Common Work Results for HVAC for additional requirements.

B. Install piping to allow for thermal expansion using offsets, loops, swing joints, expansion joints, vibration isolation and anchors as necessary to limit stress. Connect risers, branches and run outs to terminal equipment to main or branch lines with at least three pipe fittings, including tee in main or branch.

C. During construction, provide temporary end caps on all piping to prevent dirt and debris from entering the piping system.

D. Use only long radius elbows having a center line radius of 1.5 pipe diameters for copper and steel systems. In Victaulic installations, standard "as-cast full-flow" fittings shall be used.

E. "Weld-o-lets" and "Thread-o-lets" may be used for branch takeoffs up to one-half (1/2) the diameter of the main.

F. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with chained cap, at low points in piping system mains and elsewhere as required for complete system drainage.

G. Install all valves, control valves and piping specialties including items furnished by others as specified and/or detailed. Make connections to all equipment installed by others where that equipment requires the piping service indicated in this section.

H. Install dielectric fittings in piping systems where indicated and at connections of dissimilar metals: including but not limited to steel to copper connections. Install unions or flexible hose connectors with unions for piping NPS 2 (DN 50) and smaller. Install flanges for piping NPS 2-1/2 (DN 65) and larger. Teflon tape is not acceptable substitute for a dielectric fitting.

I. Install unions in piping, NPS 2 (DN 50) and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated. Identify on exterior of insulated cold piping systems locations of unions. Unions are to be installed on the equipment side of shut-off valves.

J. Flexible hose connectors with unions may be applied for piping NPS 2 (DN 50) and smaller for connections to equipment and to facilitate flushing of piping systems. Coordinate application with vibration isolation specifications. Flexible hose connectors are to be installed on the equipment side of shut-off valves.

K. Install flanges in piping, NPS 2-1/2 (DN 65) and larger, at final connections of equipment and elsewhere as indicated.

L. Unions and flanges for servicing and disconnect are not required in installations using grooved mechanical joint couplings. (The couplings shall serve as disconnect points if required.)

M. Install branch connections to mains with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

N. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

O. Route condensate piping to nearest approved sanitary or storm drain receptor per requirements of authority having jurisdiction. For rooftop units, route condensate piping from unit drain trap to nearest approved drain. Elevate piping and secure to roof per code requirements.

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC."

B. Mounting and anchoring requirements for seismic installations are specified in Division 23 Section "Seismic Restraint for HVAC."

3.5 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections and associated specialties shall be the larger of that indicated on the plans or the associated equipment connection. Branch transitions, when required, shall be located at the point of connection to the equipment.

B. Install control valves and strainers in accessible locations close to connected equipment.

3.6 FIELD QUALITY CONTROL

A. Prepare hydronic piping for hydrostatic pressure test according to ASME and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush and clean hydronic piping systems with clean water; then remove and clean or replace strainer screens. Refer to Common Work Results for HVAC for additional requirements.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve.

5. Install temporary pressure relief valves, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following piping system hydrostatic leak tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and make up water and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure at low elevation point of the system that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stresses do not exceed values in ASME. Hydrostatic test piping systems at the higher value of 100 psig or 1.5 times the system's working pressure.

   a. Note: Some manufacturers of various system components such as press fittings require a lower pressure test. Should the contractor install any system components that the manufacturer specifically requires a lower pressure test, this shall be completed prior to that indicated here. The manufacturers testing requirements shall be adhered to.

5. Measure and record test pressure at the low point in the system.
6. After hydrostatic test pressure has been applied for at least 4 hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.
7. Reduce system pressure back to system fill pressure and reconnect expansion tank and make up water.
8. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Verify make up water pressure reducing valve is set for required system pressure.
4. Install pressure relief valve set for required system pressure.
5. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
6. Set temperature controls so all coils are calling for full flow.
7. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
8. Verify lubrication of motors and bearings.

END OF SECTION

SECTION 23 21 17 - HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:

1. Air Vents
2. Strainers
3. Flexible Hose Connectors
4. Thermometers and gauge wells

B. Related Sections include :

1. Division 23 Section “Seismic Restraint for HVAC”.
2. Division 23 Section “Vibration Controls for HVAC”.
3. Division 23 Section “Hydronic Piping”.

1.3 PERFORMANCE REQUIREMENTS

A. Products shall be suitable for piping system fluids, materials, pressures, and temperatures.

B. Hydronic piping specialties and installation shall withstand the minimum design pressure and temperature and test pressure as specified in Hydronic Piping.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of specialty indicated, provide product data including applicable dimensions, capacities, materials of construction, non-compatible fluids and pressure and temperature ratings.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For hydronic specialties, include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Hydronic piping and specialties, safety valves, pressure vessels shall be fabricated and installed to comply with ASME. Safety valves, relief valves and pressure vessels shall be ASME labeled to comply with ASME standards including Boiler and Pressure Vessel Code.

B. Pipe Welding: Qualify procedures and operators according to ASME standards including Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Hydronic piping specialties and installation shall be suitable for indicated service with design pressure and temperature ratings as indicated in Part 1 “Performance Requirements” Article.

B. Hydronic piping specialties and installation shall withstand 1.5 times the system’s working pressure for pressure test requirements.

C. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger. End connections may be pressure seal or grooved compatible with associated piping systems when specified in Hydronic Piping.

D. Finish: Manufacturer’s standard paint or galvanized construction to resist corrosion for specialties constructed of steel.

E. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amtrol, Inc.
2. Armstrong Pumps, Inc.
3. Bell & Gossett Domestic Pump; a division of ITT Industries.
4. Griswold
5. Flow Design, Inc
6. Metraflex.
7. Mueller Steam
8. Nibco
9. Red-White Valve Corp.
10. Taco.
11. The John Wood Company
12. Spirotherm.
13. Victaulic Company.

2.2 AIR CONTROL

A. Manual Air Vents:

1. NPS 1/4 brass needle type valves with screwed cap.
2. NPS 1/2 full-port, two piece bronze ball valve with screwed cap and chain.
3. Waste Connector: When indicated to pipe vents to drains.

B. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. High Capacity type: NPS 3/4 inlet and NPS 3/8 outlet.
5. Standard Capacity type: NPS 1/2 inlet and 1/4 outlet with manufacturer's screw cap.
6. Waste Connector: When indicated to pipe vents to drains.

2.3 STRAINERS

A. Y-Pattern Strainers:

1. Body:

a. ASTM A 126 cast iron with screwed cap or bolted cover and bottom drain connection.
b. ASTM A 536 ductile iron with coupled cap for strainer access.
c. ASTM B 62 bronze with screwed cap and bottom drain connection.

2. Strainer Screen: Stainless steel 20 mesh strainer for NPS 2 (DN 50) and smaller, and perforated stainless-steel basket with stainless steel fine mesh start up screens for NPS 2-1/2 (DN65) and larger as indicated in Part 3.
3. Blow down: Blow down ball or gate type valve with hose end connection and chained cap when blow down is not piped to drain.

2.4 FLEXIBLE HOSE CONNECTOR

1. Flexible stainless 25 / 50 fire smoke rated steel hose assembly NPS 2 and smaller, rated for pressures to 400 PSI, minimum, at 200 F. Construction shall include an inner CEP or EPDM tube with a stainless steel braded cover with brass threaded fittings with a swivel union fitting at one end to allow removal for service and short circuiting the coil during flushing. Flexible connections shall be suitable for pressure, temperature and fluid for intended service.
2. Minimum bend radius of 7" for ¾" hose, 8" for 1", 10" for up to 2".
3. Hose to be pressure tested to 450 psi.

2.5 THERMOMETERS AND GAUGES

A. Test Plugs

1. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

B. Liquid-In-Glass Thermometers

1. Case: Cast aluminum; 9-inch nominal size.
2. Case Form: Adjustable angle unless otherwise indicated.
3. Tube: Glass with magnifying lens and fill of spirit type blue organic liquid.
4. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.

C. Thermowells

1. Manufacturers: Same as manufacturer of thermometer being used.
2. Provide for all thermometers and temperature sensors in hydronic piping systems.
3. Description: Pressure-tight, socket-type stainless steel fitting made for insertion into piping and of type, diameter, and length required to hold thermometer. Provide extension neck for insulated piping systems.

D. Stems

1. Aluminum, brass or stainless steel construction for use with thermowell in piping systems.
2. Air duct style with perforated guard for use with ductwork. Provide stainless steel construction for use in stainless steel, aluminum or corrosion resistant coated duct systems.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine specialties interiors for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Examine threads and mating pipe for form and cleanliness.

C. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

D. Do not attempt to repair defective valves and specialties; replace with new.

3.2 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.3 INSTALLATION

A. Hydronic specialties and installation shall suitable for indicated service with design pressure and temperature ratings as indicated in Part 1 “Performance Requirements” Article.

B. Specialties to be compatible with associated piping systems utilizing soldered, brazed, press fittings, grooved, screwed, welded or flanged fittings as indicated in Part 2 specifications.

C. Compliance: In accord with approved submittals and manufacturer’s written installation instructions.

D. Provide stainless steel construction option for specialties when used on piping systems in corrosive environments. Refer to Division 23 Section "Hydronic Piping" for systems considered corrosive.

E. Flexible hose connectors with unions may be applied for piping NPS 2 (DN 50) and smaller for connections to equipment and to facilitate flushing of piping systems. Coordinate application with vibration isolation specifications. Flexible hose connectors are to be installed on the equipment side of shut-off valves. Flexible hose connector size shall be runout size and not equipment connection size.

F. Identify specialties as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

G. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Utilize high capacity type at air separator. Install shut off valve upstream of each automatic air vent for service.

H. Install manual air vents at high points of system piping, heat-transfer coils and elsewhere as required for air venting and system draining.

I. Route air vents to drain when indicated with copper or PEX tubing. Provide chained caps for manual air vents when not routed to drain.

J. Install thermometer and gauges in locations indicated on the drawings and details.

1. Install gauges for water service with pressure snubbers and gauge valves.
2. Install thermometers with heat transfer paste in thermowells with minimum stem insertion lengths of 2”.
3. For pipe sizes 2” and smaller, install thermowells in side tap of full size piping tee with stem insertion length of approximately ½ pipe size .

4. Adjust faces of thermometers and gauges to proper angle for best visibility.

K. Install gauge and thermometer tapings at each point where a sensing device is required under Division 23 Sections "Instrumentation and Control for HVAC" and “Sequence of Operations for HVAC Controls” and at locations as shown on the drawings and details. Install gauge tapping with snubbers and gauge valves.

L. Install test plugs in water systems as detailed and on entering and leaving side of all strainers, heat exchangers, water coils, chillers and pumps, and at control system pressure and temperature sensors.

M. Strainers:

1. Provide strainers on inlet side of each control valve, pressure-reducing valve, pump and elsewhere as indicated. Install blow down valve same size as blow down connection.
2. Provide 20 mesh start-up screens at pump strainers and basket strainers removed prior to test and balance and utilize operating screens.
3. Provide the following operating screens for water systems:

a. Upstream of control valves:

1) 20 mesh for pipes sizes from ½” to 2”.
2) 3/64” perforations for pipe sizes from 2-1/2” to 3”.
3) 1/8” perforations for pipe sizes 4” and above.

N. Provide blow down valve with hose end thread connection and chained cap when blow down is not piped to drain

O. Flexible Hose Connector:

1. Coordinate application with Vibration Isolation specifications.
2. Flexible hose connectors are to be installed on the equipment side of shut-off valves.

END OF SECTION

SECTION 23 21 24 – CONDENSATE PIPING AND PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related sections include the following:

1. Division 23 Section "Common Motor Requirements for HVAC Equipment."

1.2 SUMMARY

A. This Section includes the following:

1. Condensate piping
2. Condensate pumps.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Condensate Piping:

a. Product Data: For each type of the following, provide product data:

1) Pipe and fittings.

2. Condensate Pumps:

a. Include certified performance and rated capacities, operating characteristics, furnished specialties, and accessories for each pump.
b. Unit dimensions, weight and appropriate identification.
c. Motor ratings, RPM, electrical characteristics and motor accessories

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Listed and labeled per requirements of UL and UL Canada.

C. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.

D. All plastic pipe, joint couplings, fittings, and valves shall be of the same manufacturer when available.

1.6 DESIGN CRITERIA

A. All pumps shall operate without objectionable noise or vibration.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Retain protective covers for protective coatings during storage.

B. Protect unit against damage from sand, grit, and other foreign matter.

PART 2 - PRODUCTS

2.1 CONDENSATE PIPING

A. Copper Tube and Fittings

1. Drawn-Temper (hard) Copper Tubing: ASTM B 88, Type L.
2. Copper and Copper Alloy Fittings: Soldered or brazed joints.

B. Joining Materials

1. Pipe-Flange Gasket Materials: Nonmetallic, flat, asbestos-free, suitable for chemical, thermal and pressure conditions of piping system contents and piping components being joined.

2.2 CONDENSATE PUMPS

A. Basis of Design Product: Provide the following product or equal unit by Hartell:

1. Little Giant Pump Co., Model VCCA-20-P

B. Description: Suitable for required service. UL-2043, plenum rated for mounting in ceiling cavity packaged units with corrosion-resistant pump, aluminum or plastic tank with cover,

discharge check valve, and automatic controls rated for air conditioning condensate applications with water temperature up to 140 deg F. Include factory installed controls with two float design, to start and stop pump and to prevent condensate overflow.

C. Include factory hard wired connection. Plug-in type or corded type are not allowed.

D. Unit rated for 45 gallons per hour at 10 feet lift with 20 feet shut off head.

E. Electrical

1. Pumps shall be supplied with means of disconnect and overcurrent protection in accordance with mechanical, control and electrical specifications.
2. Disconnect Switch: Locate on unit.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONNECTIONS

A. Install piping adjacent to machine to allow service and maintenance.

B. Connect piping to pumps. Install check valves at discharge of unit if unless integral to unit. When pump connection size and pipe size indicated are not identical, provide necessary concentric reducers/increasers the pump connection.

C. Install pipe sizes equal to or greater than diameter of pump inlet/outlet.

D. Install electrical connections for power, controls, and devices.

3.3 CONDENSATE PIPING INSTALLATION

A. Schedule: Condensate-Drain Piping shall be any of the following:

1. Copper tubing (hard), copper and copper alloy fittings.

B. Transition Fittings: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer’s written instructions.

C. Piping Joint Construction

1. Ream ends of pipes and tubes and remove burrs.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Plastic piping joints to be made in accordance with the piping and fitting manufacturer's instructions.
4. Copper Pipe Joints:

    a. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

D. Route condensate piping to nearest approved sanitary or storm drain receptor per requirements of authority having jurisdiction. For rooftop units, route condensate piping from unit drain trap to nearest approved drain. Elevate piping and secure to roof per code requirements.

3.4 PUMP INSTALLATION

A. Compliance: In accordance with approved submittals and manufacturer's written installation instructions.

B. Install units for collecting air conditioning condensate from systems where condensate cannot flow by gravity and extend to open drain. Interlock condensate pump float switches in series with primary condensate overflow protection to de-energize associated unit to prevent condensate overflow.

C. Install pumps with access for periodic maintenance.

3.5 FIELD QUALITY CONTROL

A. Perform test, inspections and prepare test reports including:

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that unit is secure on supporting devices and that connections to piping and electrical systems are complete.
3. Check piping connections for tightness.

END OF SECTION

SECTION 23 22 13 – STEAM AND CONDENSATE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:

1. Steam and steam condensate piping.
2. Makeup-water piping.
3. Drain and Vent piping.
4. Safety-valve-inlet and -outlet piping.

B. Related Sections include:

1. Division 23 Section “Seismic Restraint for HVAC”.
2. Division 23 Section “Vibration Controls for HVAC”.
3. Division 23 Section “Hangers and Supports for HVAC”.

1.3 DEFINITIONS

A. Design Pressure: Minimum required pressure rating requirement at indicated operating temperature of piping systems and associated valves, fittings, and specialties for sustained operation.

B. Maximum System Design Pressure: Maximum sustained operating pressure during normal operating conditions in associated piping systems.

C. Working Pressure: Maximum sustained operating pressure during normal operating conditions in associated piping systems.

D. LP Systems: Low-pressure piping operating at 15 psig or less.

1.4 PERFORMANCE REQUIREMENTS

A. Steam piping and steam condensate piping, components, fittings, specialties and installation shall withstand the following minimum design pressure and temperature:
1. LP Systems

a. Working Pressure: 15 psig.
b. Design Pressure:

1) Steam Supply Schedule 40 steel Pipe: 125 psig at 200 deg F.
2) Steam Condensate - Schedule 80 steel Pipe: 125 psig at 200 deg F.

2. Makeup-Water: Equal to the pressure of the piping system to which it is attached.
3. Drain, Vent, Vacuum-Breaker Piping: Equal to the pressure of the piping system to which it is attached.
4. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

B. Steam piping and steam condensate piping, components, fittings, specialties and installation shall withstand pressures required by pressure test requirements of these specifications. Pressure test to be performed at reduced temperature.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of the following, provide product data for all items including as applicable dimensions, capacities, materials of construction, non-compatible fluids, pressure and temperature ratings, pressure drop and appropriate identification:

1. Pipe and fittings.

1.6 QUALITY ASSURANCE

A. Steel Support Welding: Qualify procedures and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with ASME B31.1 “Power Piping” and ASME B31.9, "Building Services Piping," for materials, products, and installation.
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

PART 2 - PRODUCTS

2.1 General:

A. Steam and steam condensate piping, components, fittings, specialties and installation shall be suitable for indicated service with design pressure and temperature ratings as indicated in Part 1 “Performance Requirements” Article.

B. Steam and steam condensate piping, components, fittings, specialties and installation shall withstand 1.5 times the system's working pressure for pressure test requirements.

2.2 STEEL PIPE AND FITTINGS – LP Systems

A. Steel Pipe – Steam 2" and smaller: ASTM A 53/A 53M, black steel with plain ends; Grade B, type E electric resistance welded, or Grade A, type F continuously welded, schedule 40.

B. Steel Pipe – Steam Condensate 2" and smaller: ASTM A 53/A 53M, black steel with plain ends; Grade B, type E electric resistance welded, or Grade A, type F continuously welded, schedule 80.

C. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125, 250 or higher as required by Part 1 "Performance Requirements" Article.

D. Malleable and ductile Iron Threaded Fittings: ASME B16.3, Classes 150, 300 or higher as required by Part 1 "Performance Requirements Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 125, 250 or higher and bolt holes spot faced as required by Part 1 "Performance Requirements" Article.

F. Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets.

H. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, black steel of same Type, Grade, and Schedule as pipe in which installed.

2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

D. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

PART 3 - EXECUTION

3.1 PIPING SCHEDULES

A. Steam and steam condensate piping, components, fittings, specialties and installation shall suitable for indicated service with design pressure and temperature ratings as indicated in Part 1 “Performance Requirements” Article.

B. Fittings, specialties and valves to be compatible with associated piping systems utilizing screwed, welded or flanged fittings as indicated in Part 2 specifications.

C. LP steam piping:

1. LP Steam Piping, NPS 2 and smaller, shall be steel pipe; steel, ductile or malleable iron fittings.
2. LP Steam Condensate Piping, NPS 2 and smaller, shall be steel pipe; steel, ductile or malleable iron fittings.

D. Ancillary piping:

1. Make-up-Water piping: Same materials and joining methods as for piping specified for the service in which it is installed.
2. Drain piping, Vent piping and Vacuum-Breaker piping: Same materials and joining methods as for piping specified for the service in which it is installed .
3. Safety-Valve-Inlet and -Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.2 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints: Weld steel joints according ASME code, ANSI and State codes as applicable, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 PIPING INSTALLATIONS

A. Refer to other Division 23 specifications including Common Work Results for HVAC for additional requirements.

B. Select system components with pressure ratings that meet or exceed the design pressure rating specified for the associated piping systems.

C. Use only long radius elbows having a center line radius of 1.5 pipe diameters.

D. "Weld-o-lets" and "Thread-o-lets" may be used for branch takeoffs up to one-half (1/2) the diameter of the main.

E. Install drains, consisting of a tee fitting, NPS 3/4 gate valve, and short NPS 3/4 threaded nipple with chained cap, at low points in piping system mains and elsewhere as required for complete system drainage.

F. Install all valves, control valves and piping specialties including items furnished by others as specified and/or detailed. Make connections to all equipment installed by others where that equipment requires the piping service indicated in this section.

G. Install unions in piping, NPS 2 (DN 50) and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated. Identify on exterior of insulated systems locations of unions. Unions are to be installed on the equipment side of shut-off valve.

H. Install steam piping and specialties to minimize collection of condensate in steam lines.

I. Install branch connections to steam mains with the branch connected to the top of the main pipe or 45 degrees from the top.

J. Install branch connections to steam condensate mains to drain branch condensate into the top of the main pipe. Condensate connections may be made in the horizontal plane in limited space situations.

K. Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.

L. Install gravity condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.

M. Reduce pipe sizes using eccentric reducer fitting installed with level side down.

N. Install drip legs with condensate traps at low points and drainage points of steam lines including ends of mains, bottoms of risers, ahead of pressure regulators and for branch lines to terminal devices to remove condensate from steam lines.

1. On straight runs with no natural drainage points, install drip legs at intervals not exceeding 300 feet.
2. Branch lines with control valves above the steam main which are less than 10 feet and slope back to main at a grade greater than 4% are not required to be trapped, unless required by the manufacturer.
3. Size drip legs same size as main. In steam mains NPS 6 and larger, drip leg size can be reduced to ½ the main pipe diameter, but to no less than NPS 4.
4. Provide condensate trap on drip line. Drip line and trap to be a minimum of 10" or 1.5 times the pipe diameter, whichever is greater, below the main for supervised warm up systems.
5. Provide drip legs with dirt leg and drain valve.

O. Install safety valve discharge piping to vertically to the outside as short and straight as possible installed without valves in accordance with ASME.

1. Install drip pan elbow at base of vertical discharge pipe. All vent piping to be supported independently from safety valve.
2. Run drain lines from drip pan elbow and to nearest floor drain.

P. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

Q. Install sleeves for piping penetrations of walls, ceilings, and floors.

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC."

B. Comply with mounting and anchoring requirements for seismic installations. Seismic restraints are specified in Division 23 Section "Seismic Restraint for HVAC Piping and Equipment."

3.5 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections and associated specialties shall be the larger of that indicated on the plans or the associated equipment connection. Branch eccentric transitions, when requried, shall be located at the point of connection to the equipment.

B. Install traps, Y-strainers, vacuum breaker and control valves in accessible locations close to connected equipment.

C. Install a minimum of two elbows in the pipe line connecting to terminal equipment to provide flexibility for expansion and contraction of the piping system.

D. Install offsets in terminal device pipe connections to allow for service and replacement of the terminal device.

E. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required. Select the bypass globe valve with a Cv such that the pressure drop across the bypass valve wide open is equal to the pressure drop across the control valve when it is wide open.

F. Install a drip leg with steam trap upstream of the control valve at coil inlet. Provide a Y-strainer located upstream from the control valve.

3.6 FIELD QUALITY CONTROL

A. Prepare steam and condensate piping according to ASME B31.1, "Power Piping," and ASME B31.9, "Building Services Piping," and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush and clean piping systems with clean water; then remove and clean or replace strainer screens. Refer to Common Work Results for HVAC for additional requirements.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve.
5. Install temporary pressure relief valves, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform steam and condensate piping system hydrostatic leak tests as follows:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Subject steam and condensate piping system to hydrostatic test pressure at low elevation point of the system that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stresses do not exceed values in ASME B31.9, "Building Services Piping." Hydrostatic test piping systems at the higher value of 100 psig or 1.5 times the system’s working pressure.
4. Measure and record test pressure at the low point in the system.

5. After hydrostatic test pressure has been applied for at least 4 hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.
6. Drain system, reconnect boiler and feed water and prepare to start steam system.
7. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Verify feed water pump controls are set for correct fill pressure.
3. Install safety valve set for required system pressure.
4. Verify that system is completely drained and equipment is reconnected. Start steam system with supervised startup.
5. Inspect and set operating pressure of steam equipment, such as boilers and heat exchangers.

END OF SECTION

SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes refrigerant piping and installation for air-conditioning applications.

B. This Section includes field modifications for Hot Gas Bypass to packaged air handling units.

C. This Section includes refrigerant piping and installation for Kitchen refrigeration equipment.

D. This section includes the field installation of compressors, condensers, coils, condensing units, and all other fittings, devices, and accessories required to complete the refrigeration systems as shown on the drawings.

E. For detailed installation instructions, refer to the manufacturer’s installation manuals. The contractor shall provide all necessary piping, refrigerant, and accessories required for a complete operating system.

F. This contractor is responsible for unloading, assembling, and installing all equipment and specialties.

1.3 SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include refrigerant valves and piping specialties in maintenance manuals. Include pressure drop, based on manufacturer's test data, for the following:

1. Thermostatic expansion valves.
2. Solenoid valves.
3. Hot-gas bypass valves.
4. Filter dryers.
5. Strainers.
6. Pressure-regulating valves.

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal

runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.

1. Shop Drawing Scale: 1/4 inch equals 1 foot.
2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

1.4 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.5 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.6 COORDINATION

A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 280, Type ACR.

B. Wrought-Copper Fittings: ASME B16.50.

C. Wrought-Copper Unions: ASME B16.22.

D. Brazing Filler Metals: AWS A5.8 Class BCuP-5

E. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.

2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANTS

A. Lines NPS 3/4 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

B. Lines NPS 1/2 to NPS 4 for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Nitrogen must be flowed through the inside of the piping system during any brazing operations. The piping system shall be left open at one point to prevent the nitrogen from building up any pressure inside the pipe. The nitrogen must flow into and out of the piping system during brazing to displace any oxygen inside the pipe.

C. Install refrigerant piping according to ASHRAE 15.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Manufactured brazed ASME 16.50 fittings shall be used. Field fabricated mitered elbows and tees will not be allowed.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Refer to Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operation" for solenoid valve controllers, control wiring, and sequence of operation.

L. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

M. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

N. Install refrigerant piping in protective conduit where installed belowground. Soft copper only is to be used with no joints in the underground portion.

O. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

P. Slope refrigerant piping as follows:

1. Piping slope shall be 2-1/2” per 20 feet to prevent oil trapping.
2. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
3. Install horizontal suction lines with a uniform slope downward to compressor.
4. Install traps and double risers to entrain oil in vertical runs.
5. Liquid lines may be installed level.

Q. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

R. Install pipe sleeves at penetrations in exterior walls and floor assemblies.

S. Seal penetrations through fire and smoke barriers according to Division 07 Section "Penetration Firestopping."

T. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

U. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

V. Seal pipe penetrations through exterior walls according to Division 07 Section "Joint Sealants" for materials and methods.

W. Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC Piping and Equipment."

3.3 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

D. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs.
2. Trapeze strut hangers with vibration inserts for multiple horizontal piping
3. Copper-clad hangers and supports for hangers and supports with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. The Contractor shall notify the Architect in advance of any test so that Owner's representatives may be present for tests if desired.

C. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.

    a. Fill system with nitrogen to the required test pressure.
    b. System shall maintain test pressure at the manifold gage throughout duration of test.
    c. Test joints and fittings with electronic leak detector and by brushing a small amount of soap and glycerin solution over joints.
    d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.6 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 250 micrometers. Turn off vacuum pump and isolate system. If vacuum holds for 12 hours, system is ready for charging.

3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.

3.7 ADJUSTING

A. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves except bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

3.8 OPERATION AND CHECK-OUT

A. Contractor shall be responsible for the proper adjustment of all refrigeration controls in the system, including controls on each refrigeration circuit, air temperature controls in the machine room, remote condenser controls, water regulation valves, or other related controls.

B. The contractor shall check the compressor overload protectors with the manufacturer's specifications, and inform the Architect if they are incorrect.

C. The contractor shall check and make any adjustments to the controls during the first 4 hours of system operation. The contractor's refrigeration mechanic shall remain on site all day during the first day of full operation of each system.

D. Include Operation and Check-out report with close-out documents.

END OF SECTION

SECTION 26 29 23 - VARIABLE-FREQUENCY DRIVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes separately enclosed, pre-assembled, combination VFDs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

B. Specific requirements, i.e., voltage, horsepower, etc., for the VFD shall be as indicated on the drawings.

C. Related Sections include the following:

1. Division 26 Section "Motor-Control Centers" for VFDs installed in motor-control centers.
2. Division 26 Section “Enclosed Controllers” for Reduced Voltage Solid State starter requirements.
3. Division 26 Section "Seismic Restraint For Electrical Systems" for requirements necessary for compliance with seismic criteria.

D. Division 23 Contractor shall furnish all VFDs unless located in motor control centers. Division 26 Contractor shall furnish all VFDs located in motor control centers.

1.3 DEFINITIONS

A. CE: Conformite Europeene (European Compliance).

B. CPT: Control power transformer.

C. IGBT: Insulated-gate bipolar transistor.

D. LED: Light-emitting diode.

E. PCC: Point of common coupling.

F. PWM: Pulse-width modulated.

G. RFI: Radio-frequency interference.

H. TDD: Total demand (harmonic current) distortion.

I. THD(V): Total harmonic voltage demand.

J. VFD: Variable-frequency motor controller / drive

1.4 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFD indicated. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, and furnished specialties and accessories.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification: Manufacturer's certification of seismic qualification according to ASCE 7. Submit ASCE 7 special seismic certification as required. Include method used to determine compliance with requirements.

1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Harmonic Analysis Study and Report: Comply with IEEE 399 and NETA Acceptance Testing Specification; identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze possible operating scenarios, including recommendations for VFD input filtering to limit TDD and THD(V) at each VFD to specified levels.

a. Prior to installation, the VFD manufacturer shall provide the estimated total harmonic distortion (THD) caused by the VFD's. The results shall be based on a computer aided circuit simulation of the total actual system, with information obtained from the power service provider and the user.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VFDs to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and MCP trip settings.
2. Manufacturer's written instructions for setting field-adjustable overload relays.
3. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
4. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
2. Indicating Lights: Two of each type and color installed.

1.8 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the California Electric Code (CEC), by a qualified testing agency, and marked for intended location and application.

B. Comply with the CEC.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store VFDs in dry, low humidity location prior to installation.

1.10 COORDINATION

A. Coordinate features of motors, load characteristics, installed units, and accessory devices to be compatible with the following:

1. Torque, speed, and horsepower requirements of the load.
2. Ratings and characteristics of supply circuit and required control sequence.
3. Ambient and environmental conditions of installation location.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFDs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.
2. The warranty shall include parts, labor, travel and all associated living expenses incurred by the manufacturer to provide factory authorized on-site service. The warranty shall be provided by the VFD manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB.
2. Danfoss Inc.; Danfoss Drives Div.
3. Rockwell Automation, Inc.; Allen-Bradley Brand.
4. Square D; a brand of Schneider Electric.
5. Yaskawa Electric America, Inc; Drives Division.

B. General Requirements for VFDs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.

C. Application: Variable torque.

D. VFD Description: Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency. The solid state VFD shall employ a full wave rectifier, AC input / output Line Reactors, capacitors, and IGBT's as the output switching device.

1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

E. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

F. Output Rating: Three-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

G. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFD input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding 5 percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFD frequency rating.

4. Minimum Efficiency: 97 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or speed condition.
6. Minimum Short-Circuit Current (Withstand) Rating: [**65**] [**100**] kA.
7. Vibration Withstand: Comply with IEC 60068-2-6.
8. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
9. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
10. Speed Regulation: Plus or minus 10 percent.
11. Output Carrier Frequency: Selectable; 0.5 to 8 kHz. In addition, the output carrier frequency shall be randomly modulated about the selected frequency.
12. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

H. Inverter Logic: Microprocessor based, isolated from all power circuits.

I. Isolated Control Interface: Allows VFDs to follow remote-control signal over a minimum 40:1 speed range.

1. Signal: Electrical.

J. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 0.1 to 999.9 seconds.
4. Deceleration: 0.1 to 999.9 seconds.
5. Current Limit: 30 to minimum of 150 percent of maximum rating.

K. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Under- and overvoltage trips.
4. Inverter overcurrent trips.
5. VFD and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFDs and motor thermal characteristics, and for providing VFD overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
6. Critical frequency rejection, with selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Reverse-phase protection.
9. Short-circuit protection.
10. Motor overtemperature fault.
11. Ground fault.

12. The VFD motor control circuitry shall be protected from sustained power or phase loss. This protection shall utilize an under-voltage relay located on the secondary side of the 120 volt AC control power transformer and be set to deactivate all power circuitry if the voltage drops below the safe operating range (95 volts AC) of the mechanical contactors.

L. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

M. Bidirectional Autospeed Search: Capable of starting VFD into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

O. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

P. Integral Input Disconnecting Means and OCPD: NEMA AB 1, instantaneous-trip circuit breaker with pad-lockable, door-mounted handle mechanism.

1. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFD input current rating, whichever is larger.
2. Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.
3. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.

Q. NO alarm contact that operates only when circuit breaker has tripped.

R. The drive shall employ a current limit circuit to provide trip free operation and shall have the capability to be set between 40 and 110 percent of the drive controller output. The current limit shall be able to be set either manually via the keypad, by a frequency level, by a logic input or by an analog input.

S. The VFD shall be optimized for a 4 kHz carrier frequency to reduce motor noise and provide high system efficiency. The carrier frequency shall be adjustable by the start-up engineer or the drive shall have the capability to inject a white noise down the motor leads to reduce motor noise.

T. Galvanic and/or optical isolation shall be provided between the drive's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. Drives not including isolation on both analog I/O and discreet I/O shall include additional isolation modules as manufactured by Action Instruments, Inc.

U. Customer Interlock Terminal Strip - provide a separate terminal strip for connection of emergency stop signals for: freeze, fire, smoke contacts, external start command and run status contact. All external interlocks and start/stop contacts shall remain fully functional whether the drive is in Hand, or Auto.

V. Door interlocked circuit breaker disconnect switch which will disconnect all input power from the drive and all internally mounted options. The disconnect handle shall be thru-the-door type, and be padlockable in the "Off" position.

2.2 CONTROLS AND INDICATION

A. Panel-Mounted, 3-position Hand-Off-Auto Switch: When in "Hand", the VFD will be started, and the speed will be controlled from the speed potentiometer. When in "Off", the VFD will be stopped. When in "Auto", the VFD will start via an external contact closure, and its speed will be controlled via an external speed reference

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

1. Keypad: In addition to required programming and control keys.
2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.

a. Control Authority: Supports at least four conditions: Off, local manual control at VFD, local automatic control at VFD, and automatic control through a remote source.

C. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

D. Indicating Devices: Digital display mounted flush in VFD door and connected to display VFD parameters including, but not limited to:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Fault or alarming status (code).
6. Motor output voltage (V ac)
7. Elapsed Time Meter.
8. kWh meter.

E. Control Signal Interfaces:

1. Electric Input Signal Interface:

a. Two (2) programmable analog inputs shall accept a current or voltage signal for speed reference, or for reference and actual (feedback) signals for PI controller. Analog inputs shall include a filter; programmable from 0.01 to 10 seconds to remove any oscillation in the input signal. The minimum and maximum values (gain and offset) shall be adjustable within the range of 4 - 20 mA and 0 - 10 Volts. Additionally, the reference must be able to be scaled so that maximum reference can represent a frequency less than 60 Hz, without lowering the drive maximum frequency below 60 Hz.

b. Two (2) programmable digital inputs for maximum flexibility in interfacing with external devices. One dedicated non-programmable digital input is to be utilized as a customer safety connection point for fire, freeze, and smoke interlocks (Enable). The stop mode utilizing this input shall be coast to rest. Upon remote customer reset (reclosure of interlock), drive is to resume normal operation. All safety inputs shall be fully operational in all modes of operation.

2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:

a. 0- to 10-V dc.
b. 4- to 20-mA dc.
c. Potentiometer using up/down digital inputs.
d. Fixed frequencies using digital inputs.

3. Electronic Output Signal Interface:

a. Two (2) programmable analog outputs proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, or Active Reference.

b. Two (2) programmable digital relay outputs. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 amps at 250 VAC; Maximum voltage 300 VDC and 250 VAC; Continuous current rating 2 amps RMS. Outputs must be true form C type contacts; open collector outputs are not acceptable.

F. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.

1. Number of Loops: One.

G. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFD status and alarms and energy usage. Allows VFD to be used with

an external system within a multidrop LAN configuration; settings retained within VFD's nonvolatile memory.

1. Network Communications Ports: Ethernet and RS-422/485.
2. Embedded BAS Protocols for Network Communications: ASHRAE 135 BACnet Johnson Metasys N2 Modbus/Memobus, and FLN; protocols accessible via the communications ports.
3. Coordinate with DDC temperature control system being furnished for type of protocol to be provided and if different than one of the standard protocols, provide necessary interface module.
4. As a minimum the following points shall be controlled and/or accessible:

a. Drive start/stop
b. Speed set adjustment
c. Indication of setting of VFD three position selector switch.
d. Meter points

1) Motor power in kW or HP
2) Motor current
3) Motor frequency/speed

H. Three (3) programmable critical frequency lockout ranges to prevent the VFD from continuously operating at an unstable speed.

I. Four (4) programmable preset speeds.

J. The VFD shall Ramp or Coast to a stop, as selected by the user.

K. For fan and pump applications, the acceleration and deceleration profile shall be an S-curve to avoid abrupt speed changes.

2.3 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit TDD and THD(V) at the defined PCC per IEEE 519.

B. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

C. The VFD shall have an input AC line reactor that has a minimum of 5% impedance to reduce the harmonics to the power line and to increase the fundamental power factor.

D. The VFD shall have a dv/dt output load reactor to limit the peak voltage generated by the inverter to not greater than 1000 volts at the motor. Shall be provided where used with existing motors or where distance between VFD and motor exceeds 100 feet. Load reactors shall be constructed with IGBT protection and have a 4000 volt rms (5600V peak) insulation dielectric strength and meet UL 506 and UL 508 requirements.

2.4 ENCLOSURES

A. VFD Enclosures: NEMA 250, to comply with environmental conditions at installed location.

a. Indoor Dry and Clean Locations: Type 1.
b. Outdoor Locations: Type 3R.

2.5 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFD enclosure cover unless otherwise indicated.

1. Push Buttons: Recessed, momentary, heavy-duty type.
2. Pilot Lights: LED, push to test, heavy-duty type.
3. Selector Switches: Rotary, heavy-duty type.

B. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

C. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

D. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4, Type 4X, and Type 12 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

E. Cooling Fan and Exhaust System: For NEMA 250, Type 1; UL 508 component recognized: Supply fan, with intake and exhaust grills and filters; 120 -V ac; obtained from integral CPT.

F. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

2.6 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFDs according to requirements in NEMA ICS 61800-2.

1. Test each VFD while connected to a motor that is comparable to that for which the VFD is rated.
2. Verification of Performance: Rate VFDs according to operation of functions and features specified.

B. VFDs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFDs, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine VFD before installation. Reject VFDs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 HARMONIC ANALYSIS STUDY

A. Perform a harmonic analysis study to identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze possible operating scenarios, including recommendations for VFD input filtering to limit TDD and THD(V) at each VFD to specified levels.

B. Prepare a harmonic analysis study and report complying with IEEE 399 and NETA Acceptance Testing Specification.

3.3 INSTALLATION

A. Coordinate layout and installation of VFDs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Wall-Mounting Controllers: Install VFDs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

C. Floor-Mounting Controllers: Install VFDs on concrete bases complying with Division 26 Section "Common Work Results for Electrical."

D. The contractor shall complete all wiring in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual. Power wiring shall be installed in metal conduit from the drive to the motor.

E. Where a remote disconnect at the motor is provided for a motor controlled by an adjustable frequency drive, coordinate with the supplier of the disconnects to ensure that a late make, early break auxiliary contact rated for ten amps continuous duty is provided on the disconnect. This auxiliary contact shall be wired into the VFD emergency shutdown (coast to stop) circuit to ensure shutdown of the VFD in the event of the remote disconnect being opened. Damages resulting from equipment failures due to omission of this safety device shall be the responsibility of the Contractor. Provide the required control wiring between the disconnect switch and VFD.

F. Comply with mounting and anchoring requirements for seismic installations.

G. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

H. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."

I. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

J. Comply with NECA 1.

3.4 STARTUP SERVICE

A. The manufacturer shall provide start-up commissioning of the VFD and its optional circuits by a factory certified service technician who is experienced in start-up and repair services. The commissioning personnel shall be the same personnel that will provide the factory service and warranty repairs at the customer's site. Sales personnel and other agents who are not factory certified technicians for VFD field repair shall not be acceptable as commissioning agents. Start-up services shall include checking for verification of proper operation and installation for the VFD, its options and its interface wiring to the building automation system. Include a copy of the Start-Up Report in the close-out documents. Manufacturer shall provide a minimum of one trip for every four (4) VFD's.

B. The start-up report shall include the following information in addition to the manufacturer's standard information:

1. BAS (Building Automation System) input signals and ranges.
2. Low speed limit points as defined by BAS or the fan and pump manufacturer's representative.
3. Motor amp and kW at low limit and high limit speeds.
4. Acceleration and deceleration settings.

3.5 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Engineer before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "System Studies."

F. Set field-adjustable pressure switches.

3.6 PROTECTION

A. Replace VFDs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFDs at the time of the equipment commissioning.

END OF SECTION

SECTION 23 31 13 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round and flat-oval ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.

B. Related Sections include:

1. Division 23 Section “Hangers and Support for HVAC” for hangers and supports.
2. Division 23 Section “Vibration Controls for HVAC Piping and Equipment” for vibration isolation.
3. Division 23 Section “HVAC Insulation” for ductwork external insulation.
4. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
5. Division 23 Section "Seismic Restraint For HVAC" for requirements necessary for compliance with seismic criteria.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, fittings and hangers and supports to comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and requirements of Part 3Articles.

B. Structural Performance: Design duct hangers and supports and seismic restraints to withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems" and ASCE 7 as Delegated Design.

C. Comply with applicable SMACNA Standards.

D. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

E. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."

G. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

H. All system products provided for this project shall conform to NFPA Section 90A and possess a flame spread rating of not over 25 and a smoke developed rating no higher than 50.

I. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

B. Shop Drawings: Completely coordinated with all other trades and include:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Double line duct layout drawings indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top and bottom of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including all dampers (manual, control, fire/smoke), turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.
13. Unresolved conflicts between trades shall be clearly noted.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality control reports: Duct leak testing reports as required by Part 3.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 - PRODUCTS

2.1 GENERAL

A. All manufactured ductwork and fittings shall be manufactured by a company whose primary business is single wall and double wall spiral duct and fittings and double wall rectangular duct and fittings who has been in business for ten (10) years, minimum.

2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA Standards suitable for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, duct reinforcement and other provisions in SMACNA Standards.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA Standards suitable for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, duct reinforcement and other provisions in SMACNA.

D. Fittings: Select according to requirements of the drawings and specifications of similar construction to match duct system.

2.3 SINGLE-WALL MANUFACTURED ROUND DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Lindab Inc.
2. McGill AirFlow LLC
3. SEMCO Incorporated
4. Lewis & Lambert
5. Crown

B. Duct shall be machine formed round and/or flat oval spiral lock seam duct or longitudinal seam duct constructed of galvanized steel as specified suitable for pressure class specified. Use manufactured duct and fittings as indicated on the drawings and as required in accordance with manufacturer's published data.

C. The use of lighter gauge single rib ductwork is not allowed.

D. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," based on indicated static-pressure class unless otherwise indicated.

E. Transverse Joints: Select slip or flange joint types and fabricate according to SMACNA Standards suitable for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, duct reinforcement and other provisions in SMACNA Standards.

1. Transverse Joints in round ducts larger than 30 Inches in Diameter: Flanged.
2. Transverse joints in flat oval ducts larger than 24" minor or 42" major dimension: Flanged.
3. Transverse joints in round ducts up to 20 inches in diameter: O-ring Seals.

F. Longitudinal Seams: Utilize butt-welded seams fabricated according to SMACNA standards suitable for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, duct reinforcement and other provisions in SMACNA Standards. Fabricate round ducts larger than 84 inches in diameter with longitudinal seam ductwork. Fabricate flat-oval ducts larger than 77 inches in width (major dimension) with longitudinal seam ductwork.

G. Spiral Seams: Utilize spiral lock seams fabricated according to SMACNA Standards suitable for static-pressure class, applicable sealing requirements, materials involved, duct support intervals and other provisions in SMACNA Standards.

H. Fittings: Select according to requirements of the drawings and specifications of similar construction to match duct system.

2.4 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

D. Tie Rods: Galvanized steel, all thread rod, tubing or conduit sized per SMACNA Standards.

2.5 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. CertainTeed Corporation; Insulation Group.
b. Johns Manville.
c. Knauf Insulation.
d. Owens Corning.

2. Maximum Thermal Conductivity:

a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

3. For interior applications, liner thickness shall be 1 inch. For exterior applications, liner thickness shall be 2 inches.
4. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial, fungicidal coating shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems. Coating shall meet ASTM D 5590 with 0 growth rating. Coating shall be Foster Products 40-20 or approved equal.
5. Liner to be suitable for rectangular ducts with air velocities up to 4000 fpm.and temperature to 250 deg F.
6. Solvent or Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916, Type II.

B. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C534/C534M, Type II, Grade 1; and with NFPA 90A or NFPA 90B.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Aeroflex USA.
   b. Armacell LLC.
   c. K-Flex USA.

2. For interior applications, liner thickness shall be 1 inch. For exterior applications, liner thickness shall be 2 inches.
3. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
4. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B

C. Fiberglass-Free Duct Liner: Made from partially recycled cotton or polyester products and containing no fiberglass. Airstream surface overlaid with fire-resistant facing to prevent surface erosion by airstream, complying with NFPA 90A or NFPA 90B. Treat natural-fiber products with antimicrobial coating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Ductmate PolyArmor Polyester Duct Liner

2. For interior applications, liner thickness shall be 1 inch. For exterior applications, liner thickness shall be 2 inches.
3. Maximum Thermal Conductivity: 0.24 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature when tested in accordance with ASTM C518.
4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with ASTM E84; certified by an NRTL.
5. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

D. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

E. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" And manufacturer’s instructions.

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

    a. Fan discharges.
    b. Intervals of lined duct preceding unlined duct.
    c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

9. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.6 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 70 percent by volume.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Non-Fibrated.
6. Mold and mildew resistant.
7. VOC: Maximum 75 g/L (less water).
8. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
9. Service: Indoor or outdoor.

10. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

E. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.7 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

B. Hanger Rods for Corrosive Environments: Use stainless-steel or fiberglass hangers and supports for corrosive service. Use square nuts made of vinyl ester or hex nuts made of polyurethane or stainless steel.

1. Use vinyl ester resin fiberglass for “ozone” applications.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Steel Cables for Galvanized-Steel Ducts: Aircraft quality zinc coated galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Aircraft quality stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated or Zinc Cast steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials. For cable connection systems, provide rubber pads to prevent air leakage at duct connections.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

I. Building Attachment: Galvanized steel or equal corrosion resistant metal suitable for attachment to structure: concrete inserts, beam clamps, concrete anchors and welded studs. Powder-actuated fasteners may be applied if allowed by seismic constraints. See Structural drawings.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Install ducts, hangers and supports according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless the Contract Documents include more stringent requirements.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Utilize elbows, branch connections and other fittings of the type as shown on the drawings and as specified. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

C. Comply with mounting and anchoring requirements for seismic installations.

D. Install round and flat-oval ducts in maximum practical lengths.

E. Install ducts with fewest possible joints.

F. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

G. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

H. Install ducts close to walls, columns, and other structural and permanent enclosure elements of building.

I. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness. Maintain a clearance of 6 inches, for rated walls.

J. Install ducts as close as possible to underside of beams and joists.

K. Route ducts to avoid passing through electrical rooms and technology rooms.

L. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

M. Install all control dampers, fire dampers, smoke dampers and fire smoke dampers. Comply with requirements in Division 23 Section "Air Duct Accessories".

N. Use splitter dampers and/or extractors only where manual dampers will not accomplish the intended balancing. The use of splitter dampers and/or extractors will not eliminate the need for specified or indicated manual volume dampers.

O. Construct branch take off from duct main with a 45 degree entry fitting or conical fitting. Square edge 90 degree take off fittings, including spin in connections, will not be acceptable.

P. Use elbows and tees with a center line radius to width or diameter ratio of 1.5 wherever space permits. When a shorter radius elbow is required, provide short radius elbow with full length splitter vanes or mitered elbow with turning vanes.

Q. Rectangular Duct – Elbow and Tee Configuration: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Radius with minimum 1.5 radius-to-diameter ratio.
2. Short radius with full length splitter vanes Type RE 3
3. Mitered with single wall turning vanes Type RE2 .

R. Round Duct – Elbow and Tee Configuration: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Radius type with minimum 1.5 radius-to-diameter ratio.
2. Mitered type by duct manufacturer with single wall turning vanes.
3. Adjustable segmented type elbows up to 16 inch may be used for run out ducts to air inlets and outlets.
4. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.

S. Round Elbows, 14 Inches and Larger in Diameter: 5 piece gored Welded.

T. When specified in part 2, snap lock ductwork is allowed for run out ducts to air inlets and outlets up to 16 inches. The use of adjustable segmented elbows is allowed for run out ducts to air inlets and outlets up to 16 inches. All longitudinal and transverse seams shall

be sealed with duct sealant and additionally secured with sheet metal screws. Snap lock construction will not be accepted on aluminum ductwork.

U. Utilize external reinforcements, tie rods and hangers unless size of duct requires internal tie rods.

V. All duct hanger straps are required to be screwed to rectangular duct.

W. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines" exceeding SMACNA's advanced level of cleanliness.

X. Where two different metal ducts meet, the joint shall be installed to prevent metal to metal contact by using proper seal or compound.

Y. Outside air intake ducts shall pitch to intakes and drain to outside of building. Provide water tight joints and seams. Blank off all unused portions of louvers with 2 inch board insulation with galvanized sheet metal backing on both sides.

Z. All return air openings above ceilings shall be provided with a ½" mesh aluminum screen.

AA. Provide negative pressure relief fittings downstream of all closer devices and as shown on the plans and/or details (i.e., control fire, combination fire/smoke dampers, etc.).

BB. Provide duct accessories included access doors, manual dampers, control dampers, flexible ductwork, flexible connectors, relief doors per Division 23 Section "Air Duct Accessories".

3.2 ADDITIONAL INSTALLATION REQUIREMENTS OF MANUFACTURED DUCTWORK

A. Construct duct and fittings with reinforcements in accord with the manufacturer's published data and SMACNA. Remove internal shipping braces if provided.

B. Utilize external reinforcements for double wall duct systems.

C. Utilize manufacturer's slip type or flanged connectors to connect duct. Use with double wall duct sections to maintain annular space and seal insulation from the air stream. Connectors shall fit tight to the inner duct wall without projecting into the duct air stream.

D. All takeoffs or branch connections shall be provided by the duct manufacturer.

E. Seal slip joist with duct sealant and secure with sheet metal screws.

F. Seal flanged connectors with approved gasketing and secure flanges with nuts and bolts.

G. Install O-ring joints per manufacturer's requirements.

3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and other Division 23 specification sections.

B. Hanger and support Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," for maximum hanger and support spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum interval of 16 feet.

E. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used. See Structural drawings.

3.4 FIELD QUALITY CONTROL

A. Perform visual inspections of installed ductwork to assure that there aren't any gaps or leaks which would degrade system performance.

B. Perform duct leakage tests (For new HVAC systems):

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." with the allowable leakage values summarized in the table below. Submit a test report for each test.

Duct Pressure Class - P	½", 1", 2" wg	3" wg	4", 6", 10" wg
Leakage Class (CFM per 100 Sq. Ft.. of Duct Surface Area), $F_{leakage}$ = CL X $P^{.65}$			
Rectangular Metal (CL)	24	12	6
Round Metal (CL)	12	6	3

2. Test the following systems:

a. Supply Ducts with a Pressure Class of 2-Inch wg or 3-Inch wg: Test representative duct sections from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class in each system.

b. Supply Ducts with a Pressure Class of 4-Inch wg or Higher: Test 100 percent of total installed duct.

c. Return, Exhaust, and Outside Air Ducts with a Pressure Class of 2-Inch wg or higher: Test representative duct sections from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class in each system.

d. Test all vertical shafts located inside the building envelope and all supply and return ducts located outside of the building envelope (across the roof, attics, mechanical rooms vented to the outside etc.) regardless of pressure class.
e. Test grease duct systems as required by the local code enforced.
f. Test smoke control system ductwork at 1.5 times the static pressure of the system. Test 100 percent of total installed duct.

3. Duct leakage tests shall be performed while duct sections are being installed prior to installation of external insulation and finished ceilings.
4. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
5. Testing of each duct section is to be performed with access doors, coils, filters, dampers, and other duct-mounted devices in place as designed. No devices are to be removed or blanked off so as to reduce or prevent additional leakage.
6. Conduct leakage testing of ductwork at pressure rating of the duct section, positive pressure or negative pressure as specified. Increase air flow from leakage test fan gradually to prevent over pressurization of ducts. The leakage amount shall not exceed the allotted Leakage Class amount for that portion of the system.
7. Do not pressurize systems above maximum design operating pressure.
8. If excessive air leakage is found during leakage testing, locate leaks, seal, repair and repeat Leakage Test.
9. For Life Safety/Smoke Control systems: If the systems are not testing within the tolerances for leakage, repair and seal the ducts to pass the Leakage Test or utilize a product some to Aeroseal to seal the ductwork system.
10. Submit reports for review during the Construction process.

3.5 DUCT CLEANING

A. Ductwork shall be installed with cleanliness that exceeds SMACNA’s Advanced Duct Cleanliness Level as defined in SMACNA's "Duct Cleanliness for New Construction Guidelines."

B. Use duct cleaning methodology as indicated in NADCA ACR.

C. Clean ductwork internally of dust and debris, unit-by-unit as it is installed. Clean external surfaces of foreign substances which might cause corrosive deterioration of the facing.

D. Clean exposed duct systems of all dust, debris, foreign substances, and shop fabrication identification marks or stickers. Refer to Architectural requirements for painting of exposed duct systems.

E. Provide temporary duct closures of polyethylene film or other covering to prevent the entrance of dust and debris until the time connections are completed

3.6 DUCT SCHEDULE

A. Fabricate ducts as indicated in the following table:

	Galvanized Sheet metal	Aluminum Sheet	Stainless Steel Sheet	Black Steel (Uncoated)	Fiber Duct Board	Flexible Duct	**REMARKS**
Mixed Air Duct & Plenum "interior"	X						Exposed ductwork in front of house locations shall be double wall
Supply,Return, Exhaust & O.A Ducts "interior"	X						Exposed ductwork in front of house locations shall be double wall
Supply, Return, Exhaust & O.A. Ducts "exterior"	X		Opt.				[**Refer to Division 23 Section "Nonmetal Ducts" for nonmetal duct option**]
Supply/Return/Exhaust Branch Runouts "Interior"	See Remarks					X	Refer to details. Sheet metal is required for critical care applications in Healthcare Facilities Exposed ductwork in front of house locations shall be double wall
Humidifiers/Clg. Coils			X				

B. All ducts shall have a Seal Class of A, regardless of pressure class, unless noted otherwise.

C. Unless otherwise indicated on the drawings or specifications, construct all ductwork for a minimum pressure class equivalent to the positive or negative static pressure at the fan entrance or discharge, or for a 2 inch w.g. pressure class, whichever is greater.

1. Ductwork from air handling unit discharge connection to the inlet connection at the air terminal device or reheat coil shall be constructed to a minimum of 4" w.g. positive pressure class.
2. Ductwork downstream of the air terminal device or reheat coil shall be constructed to a minimum of 2" w.g. positive pressure class.
3. Return, exhaust and outside air ductwork shall be constructed to minimum of 2" w.g. negative pressure class

D. Duct Reinforcement: Provide duct bracing to meet pressure class per SMACNA Standards.

1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.

3.7 DUCT LINER

A. Duct liner is required to reduce noise levels (elastomeric type).

B. Apply lining to the following ductwork:

1. All rectangular ductwork a minimum of 6 feet downstream of air terminal devices such terminals CV and dual duct mixing boxes.
2. Ductwork 20 feet from unit connections for supply, return, and exhaust fans.

END OF SECTION

SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Backdraft dampers.
2. Manual volume dampers.
3. Combination fire and smoke dampers.
4. Flange connectors.
5. Turning vanes.
6. Remote damper operators.
7. Flexible connecters.
8. Flexible ducts.
9. Runout duct fittings

B. Related Sections include:

1. Division 23 Section “Instrumentation and Control for HVAC”.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Coordinate with ductwork specifications.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.
b. Manual volume damper installations.
c. Control damper installations.
d. Fire-damper smoke damper, combination fire and smoke damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
e. Duct security bars.
f. Duct silencer installation including distance to duct fittings

g. Wiring Diagrams: For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed

1.6 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with AMCA 500-D testing for damper rating.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Material of product shall match ductwork material.

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 BACKDRAFT DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Balance Inc.; a division of Mestek, Inc.
2. Greenheck Fan Corporation.
3. Nailor Industries Inc.
4. Pottorff; a division of PCI Industries, Inc.
5. Ruskin Company.

B. Description: Gravity balanced.

C. Maximum Air Velocity: 2000 fpm.

D. Minimum Pressure Rating: 2-inch wg or pressure rating of ductwork whichever is greater.

E. Frame: 0.052-inch-thick, galvanized sheet steel, 0.063-inch-thick extruded aluminum or 0.052-inch-thick stainless steel, with welded corners and mounting flange to match ductwork material.

F. Blades: Multiple single-piece blades, center-pivoted, maximum 6-inch width, 0.050-inch-thick aluminum sheet with sealed edges.

G. Blade Action: Parallel.

H. Blade Seals: Extruded vinyl or polyurethane, mechanically locked.

I. Blade Axles:

1. Material: Stainless steel .
2. Diameter: 0.20 inch.

J. Tie Bars and Brackets: Aluminum.

K. Return Spring: Adjustable tension.

L. Bearings: Steel ball or synthetic pivot bushings.

2.3 MANUAL VOLUME DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Balance Inc.; a division of Mestek, Inc.
2. Greenheck.
3. McGill AirFlow LLC.
4. METALAIRE, Inc.
5. Nailor Industries Inc.
6. Pottorff; a division of PCI Industries, Inc.
7. Ruskin Company.
8. VentLock

B. Standard leakage rating, with linkage outside airstream.

C. Suitable for horizontal or vertical applications.

D. Frames:

1. Hat-shaped, channels, 0.052-inch-thick, galvanized sheet steel, 0.063-inch-thick extruded aluminum or 0.052-inch-thick stainless steel to match the material of the duct in which they are installed.
2. Mitered and welded corners.
3. Flanges for attaching to walls and flangeless frames for installing in ducts.

E. Blades:

1. Multiple blade for ducts over 12 inches in height.
2. Single blade for ducts up to 12 inches in height.
3. Parallel- or opposed-blade design.
4. Stiffen damper blades for stability and to prevent vibration, flutter, or other foreign noise.
5. Minimum 22 ga. thickness in the same material as the duct the damper is installed.

F. Blade Axles: the same material as the duct the damper is installed.

G. Bearings:

1. Molded synthetic.
2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

H. Tie Bars and Brackets: same as duct material.

2.4 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers:

1. Air Balance Inc.; a division of Mestek, Inc.
2. Greenheck.
3. Nailor Industries Inc.
4. Pottorff; a division of PCI Industries, Inc.
5. Price
6. Ruskin Company.

B. Combination fire smoke damper with factory actuator, meeting the requirements of the latest edition of UL Standard 555 and 555S, suitable for application in HVAC systems. Provide dampers for vertical or horizontal as appropriate for the installation with a minimum temperature rating of 350 degree F.

C. Fire Rating: 1-1/2 and 3 hours, compatible with assembly being installed in.

D. Triple V-groove blades with seals for leakage Class I rating dynamic closure in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

E. Air foil blades with seals for leakage Class I rating dynamic closure in ducts up to 4-inch wg static pressure class and minimum 3000-fpm velocity.

F. Frame: Integral frame constructed of 16 gage roll formed galvanized steel hat shaped channel, reinforced at corners. Provide duct smoke dampers with factory mounted wall mounting sleave of length suitable for wall type.

G. Blades:

1. V-groove blades single skin with 3 longitudinal grooves constructed of minimum 16 gage galvanized steel. ACMA tested for ducted configuration with maximum air pressure drop of 0.20 inches w.g. at 2000 fpm through 24 X 24 damper assembly
2. Airfoil- shaped, single-piece of minimum 14 gage equivalent thickness, galvanized steel. ACMA tested for ducted configuration with maximum air pressure drop of 0.10 inches w.g. at 2000 fpm through 24 X 24 damper assembly

H. Bearings: Self-lubricating stainless steel sleeve, turning in extruded hole in frame.

I. Linkage: Concealed in frame with minimum ½ inch diameter plated steel axles mechanically attached to blade with actuator closure and temperature release device.

J. Heat-Responsive Device: Electric resettable link and switch package, factory installed.

1. Close in a timed controlled manner for duct pressure equalization.
2. Allow damper to be automatically and remotely reset after test or power failure.
3. Mount on same side as damper actuator.

K. Mounting Sleeve: Factory-installed, 20 gauge, or duct thickness whichever is greater, thick, galvanized sheet steel; length to suit wall or floor application including out of wall applications.

L. Damper Motors/Actuators:

1. Two-position action.
2. External out of air stream mounting
3. Electrical Connection: 120V. Contractors option to use 24V actuators plus controls contractor wiring as a pre-approved substitution including credit from Div 26 for not providing 120V wiring.
4. Actuators shall include the following:

   a. Actuator shall be furnished factory mounted to the damper.
   b. Provide spring fail safe return. Provide normally open or closed position as indicated in the points list or sequence of operation.
   c. Low voltage relay for 24V dampers.

M. Accessories:

1. Field or factory furnished mounting angles including manufacturer one sided angle.
2. Steel mullions for dampers in oversized masonry wall openings.
3. Provide sleeve and insulating material to allow for out of wall installation with damper up to 8” out of plane of wall or floor as required for the application.

4. Two position indicator switches linked directly to damper blade to remotely indicate damper position.
5. Momentary test switch, damper mounted.

6. Smoke detector.

2.5 FLANGE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Nexus PDQ; Division of Shilco Holdings Inc.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Description: roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.6 DUCT ACCESS PANEL ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide fire rated products by one of the following:

1. Ductmate Industries, Inc.
2. 3M.
3. Milcor Fire-Rated Access Doors by Greenheck.
4. Milcor Fire-Rated Access Doors by Inryco, Inc.

B. Labeled according to UL 1978 by an NRTL.

C. Panel and Frame: Minimum thickness 0.0528-inch carbon or 0.0428-inch stainless steel to match duct.

D. Fasteners: Carbon or Stainless steel, to match duct. Panel fasteners shall not penetrate duct wall.

E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.

F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.7 FLEXIBLE CONNECTERS

A. Materials: Flame-retardant or noncombustible fabrics.

B. Coatings and Adhesives: Comply with UL 181, Class 1.

C. Metal-Edged Connecters: Factory fabricated with a fabric strip 5-3/4 inches wide attached to 2 strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.

D. Indoor System, Flexible Connecter Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

E. Outdoor System, Flexible Connecter Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd..
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F.

2.8 REMOTE DAMPER OPERATIONS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Pottorff; a division of PCI Industries, Inc.
2. United Enertech.
3. Ventfabrics, Inc.
4. Young Regulator Company.

B. Description: Cable system designed for remote manual damper adjustment via rack and pinion remote control operators.

C. Tubing: Brass.

D. Cable: Stainless steel.

E. Wall-Box and Ceiling-Box Mounting: Recessed, 2 inches (50 mm) deep.

F. Wall-Box and Ceiling-Box Cover-Plate Material: Stainless steel or Chrome Plated.

G. Linear Diffusers and Linear Returns: Provide plenum mounted cable controller for mounting in the air plenum behind the face of the unit.

H. Square Diffusers: Provide cable controller with Philips head adjustments shaft for adjustment from face of the diffuser.

2.9 DUCT ACCESS PANEL ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide fire rated products by one of the following:

1. Ductmate Industries, Inc.
2. 3M.
3. Milcor Fire-Rated Access Doors by Greenheck.
4. Milcor Fire-Rated Access Doors by Inryco, Inc.

B. Labeled according to UL 1978 by an NRTL.

C. Panel and Frame: Minimum thickness 0.0528-inch carbon or 0.0428-inch stainless steel to match duct.

D. Fasteners: Carbon or Stainless steel, to match duct. Panel fasteners shall not penetrate duct wall.

E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.

F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.10 FLEXIBLE CONNECTERS

A. Materials: Flame-retardant or noncombustible fabrics.

B. Coatings and Adhesives: Comply with UL 181, Class 1.

C. Metal-Edged Connecters: Factory fabricated with a fabric strip 5-3/4 inches wide attached to 2 strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.

D. Indoor System, Flexible Connecter Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

E. Outdoor System, Flexible Connecter Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd..
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.

3. Service Temperature: Minus 50 to plus 250 deg F.

F. High-Corrosive-Environment System, Flexible Connecto\ers: Glass fabric with chemical-resistant coating.

1. Minimum Weight: 14 oz./sq. yd..
2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
3. Service Temperature: Minus 67 to plus 500 deg F.

G. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.11 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flexmaster U.S.A., Inc.

2. Thermaflex

B. Constructed from materials with flame spread index of 0-25 and a smoke developed index of 0-50 (25/50 rating) when tested in accordance with ASTM E84 (UL723), *Standard Test Method for Surface Burning Characteristics of Building Materials*. Factory-fabricated, suitable for pressures and temperatures to which duct system will be exposed and installed in accordance with the conditions of their UL listing. Tested in accordance with Sections 7 to 23 of the *Underwriters Laboratories Standard for Factory-Made Air Ducts and Air Connectors*, UL-181 Class 1 unless otherwise specified. Installed in accordance with *Air Diffusion Council (ADC) Flexible Duct Performance + Installation Standards*, 5th Edition, Chapter4, Installation Requirements.

C. Pressure rating of flexible duct, 6 inch w.g. positive, 1 inch w.g. negative, rated for a velocity of at least 4000 fpm unless otherwise specified.

D. Temperature rating of flexible duct, continuous operation at a temperature range of -20°F to +250°F unless otherwise specified.

E. Insulated flexible duct shall be constructed of an inner air barrier liner supported by and mechanically locked to a helical wound galvanize steel helix without the use of adhesives or chemicals. Factory-insulate the flexible duct with fiberglass insulation with an R value of 6 minimum at a mean temperature of 75 F. Cover the insulation with a fire-retardant metalized vapor barrier jacket reinforced with crosshatched scrim having a permeance of not greater than .05 perms when tested in accordance with ASTM E96.

F. Non-insulated, Aluminum Flexible Duct: UL 181, Class 0, aluminum construction, spiral wound into a tube and spiral corrugated of triple lock construction, Flexmaster Type NI-TL or approved equal.

1. Pressure Rating: 10-inch wg positive and 4.0-inch wg negative.
2. Maximum Air Velocity: 5500 fpm.
3. Temperature Range: Minus 20 to plus 600 deg F.

G. Non-insulated, Stainless Steel Flexible Duct: UL 181, Class 0, stainless construction, spiral wound into a tube and spiral corrugated of triple lock construction, Flexmaster Type SS-NI-TL or approved equal.

1. Pressure Rating: 10-inch wg positive and 4.0-inch wg negative.
2. Maximum Air Velocity: 5500 fpm.
3. Temperature Range: Minus 20 to plus 600 deg F.

H. Insulated, Flexible Duct: Inner air barrier liner laminated polyester film or trilaminate aluminized polyester, Flexmaster Type 5M, Thermaflex Flex-Vent KM or approved equal.

I. Acoustical Insulated, Flexible Duct: Inner air barrier liner, acoustically transparent CPE air impervious fabric, Flexmaster Type 1M, Thermaflex Type M-KE or approved equal.

1. Sound Performance: Minimum Insertion Loss for 10 foot length straight duct at a velocity of 2500 feet per minute rated in accordance with Air Diffusion Council Test Code FD 72-RI.

Octave Band	2	3	4	5	6	7
Hz	125	250	500	1000	2000	4000
6-in	11	33	37	39	37	19
8-in	13	35	34	39	29	17
12-in	10	26	26	35	24	11

J. Insulated, High Pressure Flexible Duct: Inner air barrier liner, coated fiberglass woven fabric Flexmaster Type 4M, Thermaflex Type M-KC or approved equal.

1. Pressure Rating: 10-inch wg positive, 2-inch wg negative.

K. Flexible Duct Connections:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action or Nylon strap to match duct material and to suit duct size. Sheet metal screws will not be allowed.

2.12 RUNOUT DUCT FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following;

1. Elgen.
2. Flexmaster.
3. Sheet Metal Connectors, Inc.
4. Or approved equal

B. Description: Factory-fabricated conical fittings for sheet metal or ductboard with integral volume damper. Utilize side takeoff fittings with integral volume damper with 45 degree slope on upstream side or 45 degree slopes on upstream and downstream side when indicated on the drawings or as required by duct configuration. Utilize to connect runout ducts from diffusers and grilles to submains.

C. Construction:

1. Low leakage welded seam galvanized steel, stainless or aluminum to match the material of the duct in which they are installed.
2. Spin in construction or flanged construction with neoprene gasket.
3. Integral single damper blade, 3/8” square shaft, U-bolt, nylon bushings, 2” buildout stand- off handle with locking damper quadrant handle. Dampers to be fabricated with to prevent vibration, flutter or other noise. Stand-off handle not required for non-insulated duct systems.
4. Round outlet with rolled stiffener bead for strength and sealing runout ducts.
5. Side takeoff fittings to maintain a ratio of 1 to 1 of inlet to outlet area.
6. Overall length of fitting not to exceed 13”.
7. Utilize 4” W.G. construction with or without damper as shown on the drawings when connecting to 4” pressure class duct.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft and barometric dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan or elsewhere indicated on the plans and except those specified to be by the fan manufacturer and where motor operated dampers are shown or specified to be located in the discharge ductwork.

D. Install manual volume dampers at points on supply, return, exhaust and outside air systems at all branches extending from larger ducts, including run-outs to diffusers and grilles, in addition to the dampers indicated on the plans, and as necessary to regulate the flow of air meeting the air balance requirements. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

E. Utilize runout duct fittings for runout duct to diffusers, registers and grilles where duct configuration permits, unless indicated otherwise. Fittings shall be secured and sealed to duct connections in accordance ductwork specifications.

F. Locate volume dampers as close to main duct as possible unless indicated otherwise.

G. Install dampers so as to not flutter or vibrate.

H. Damper handles shall be installed with stand-off handle to be mounted exterior to insulated ducts.

I. Attach a 24 inch long fluorescent orange plenum rated “surveyors” tape at all dampers to assist in locating dampers upon completion of installation for test and balance.

J. Install remote damper operators at all volume dampers in inaccessible locations such as above gypsum board ceilings.

K. Install smoke and combination fire/smoke dampers according to UL listing, NFPA 90A, and the manufacturer’s installation instructions. Install complete with mounting collars, retaining angles, connections to ductwork, smoke detector and duct access doors.

1. Provide combination dampers for fire/smoke rated barriers with fire rating of 1 ½ hours for rated barriers to 2 hours fire and fire rating of 3 hours for rated barriers to 3 and 4 hour fire. Coordinate fire rating type with project’s life safety plan.
2. Provide V-groove type for 1 ½ hour fire ratings in ducts with velocities up to 1750 FPM.
3. Provide airfoil type for 1 ½ or 3 hour fire ratings hour in ducts with velocities to 3000 fpm.

4. Damper sizes shall be sized equal to associated duct size.

L. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On upstream side of duct coils.
2. Upstream from duct filters.

3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links and for inspection for combination fire/smoke dampers.
6. At duct smoke detectors.
7. Upstream or downstream from duct silencers.
8. At control devices requiring inspection.
9. Upstream of elbows with turning vanes.
10. Elsewhere to service equipment.

M. Install access doors with swing against duct static pressure.

N. Provide hinged access doors or cam-latch with chain access doors in exposed applications and cam-latch type in concealed installations.

O. Install the following sizes for duct-mounting, rectangular access doors:

1. Minimum Size: 12 by 12 inches. For smaller ducts where this size is not possible, use the largest size that fits and no smaller than a minimum 12 by 6 inches for two-hand access. For even smaller ducts where the 12 by 6 inches is not possible, use the largest size that fits one-hand or inspection access.
2. For fire, smoke and combination fire/smoke dampers

   a. Provide multiple access doors if required to access multiple section dampers.
   b. If a minimum 12 by 12 inches access door cannot be installed, provide a removeable duct section.

3. Head and Hand Access: 18 by 18 inches.
4. Head and Shoulders Access: 20 by 20 inches.
5. Body Access: 24 by 24 inches.

P. Label access doors to indicate the purpose of access door. For Fire, smoke and combination fire/smoke dampers, provide labels having letters not less than 1/2 inch.

Q. Ceiling access panels shall be provided, where required, to service dampers, heaters, valves and other concealed mechanical equipment.

R. Install flexible connecters to connect ducts to equipment containing rotating or vibrating equipment, with not less than 4-incheslength of material and in accordance with SMACNA.

S. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

T. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions or to compensate for misalignment of inlet duct to terminal unit.

U. When specified, connect supply diffusers, return grilles and general exhaust grilles to ducts with flexible duct clamped or strapped in place. Minimum length of flex duct to each diffuser shall be 8'-0" with a maximum length of 12'-0" and include at least one 90 degree radius elbow. For projects in California, maximum length of flex duct shall be 5'-0".

V. Connect flexible ducts to runout fittings, sleeves, and air devices per manufacturer's installation instructions:

1. Up to 3" duct construction: 2 wraps of approved tape and draw band to secure inner core.
2. Over 3" duct construction: sealer, 2 wraps of approved tape and draw band to secure inner core.
3. For metal type flex additionally secure with sheet metal screws.
4. For insulated flex, seal outer jacket as specified for duct insulation.
5. When connecting flexible duct to round metal duct utilize metal connecting sleave to maintain duct shape.

W. When specified, connect bathroom exhaust and "wet" exhaust systems with non-insulated aluminum or stainless steel flexible duct clamped in place. Limit length of flex to a maximum of 24" and do not use flexible duct to change directions.

1. Provide slope as specified in ductwork specifications or as noted on the plans.

2. Do not use for laboratory fume hood exhaust or BSC hoods.

X. Flexible duct is not permitted in Healthcare Facilities for critical care applications.

Y. Supply and Return flex duct shall be insulated. Exhaust flex duct shall not be insulated unless part of an energy recovery system.

Z. Exhaust flex duct serving shower, bath or other wet locations shall be metal flex.

AA. For high pressure fan discharge, install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke and combination fire/smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.

5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION

SECTION 23 34 00 – FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Utility set fans.

B. Related Sections include the following:

1. Division 23 Section “Common Motor Requirements for HVAC equipment”.
2. Division 23 Section “Hangers and Supports for HVAC Piping and Equipment”.
3. Division 23 Section "Seismic Restraint for HVAC".
4. Division 23 Section “Vibration Controls for HVAC”.
5. Division 23 Section “Control Sequence”.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on sea level unless otherwise indicated.

B. Operating Limits: Classify according to AMCA 99.

C. Seismic: Fans and curb mounting assemblies shall withstand the effects of seismic forces in accordance with project Seismic specifications.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Include rated capacities, furnished specialties, dimensions, weights and accessories for each fan.
2. Certified fan performance curves with system operating conditions indicated. Fan curves shall include a series of curves indicating the relationship of CFM and static pressure for various RPM. Brake horsepower curves shall also be included. Indicate the design operating point clearly on the fan curves. Indicate fan brake horsepower requirement at the design operating point.
3. Certified octave band fan sound-power ratings.

4. Motor ratings, RPM and electrical characteristics, plus motor and electrical accessories.
5. Material thickness and finishes, including color charts.
6. Dampers, including housings, linkages, and operators.
7. Diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification: Manufacturer's certification of seismic qualification according to ASCE 7. Submit ASCE 7 special seismic certification as required. Include method used to determine compliance with requirements.

1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fans to include in operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Belts: One set for each belt-driven unit.

1.8 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. Comply with UL-705.

1.9 COORDINATION

A. Coordinate size and location of structural-steel support members and concrete bases where applicable.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations, where applicable.

1.10 DESIGN CRITERIA

A. All fans shall be tested as complete units in accordance with the applicable test code of AMCA and shall be certified by AMCA.

B. All fans with belt drives shall be provided with variable pitch V-belt sheaves for purpose of system balancing. After system is balanced, fixed pitch sheaves shall replace the variable pitch sheaves for all motors using multiple belt drives.

C. Each fan shall be selected to maintain stable fan performance at 90% of the scheduled air flow while operating at 110% of the scheduled static pressure.

D. Each fan and motor combination shall be selected to allow full speed operation: deliver 110% of the air quantity scheduled at 121% of the scheduled static pressure. Provide Class I, II or III fan construction for full speed operation of 110%, minimum, design RPM. The motor furnished with the fan shall not operate into the motor service factor in any of these cases. Drive efficiency shall be considered in motor selection according to manufacturer's published recommendations, or according to AMCA.

E. Where inlet and outlet ductwork at any fan is changed from that shown on the drawings, Contractor shall submit a scaled layout of the change and system effect factor calculations, indicating increased static pressure requirements as described in AMCA. This Contractor shall be responsible for any motor, drive and/or wiring changes required as a result of duct configuration changes at fan.

F. Where fan drives are exposed use OSHA approved belt guards that totally enclose the entire drive. Construct guards of expanded metal to allow for ventilation. Provisions shall be made so that tachometer may be used to verify fan speed without removing the guard assembly.

G. All internal insulation and other components exposed to the airstream are to meet the flame spread and smoke ratings contained in NFPA 90A.

H. Statically and dynamically balance all fans so they operate without objectionable noise or vibration.

I. Fan size, fan class, wheel type, inlet type, capacity, arrangement operating characteristics and any other special requirements shall be as indicated on the plans and/or as scheduled.

J. Fan bearings shall be heavy duty grease lubricated, ball or roller type selected for a Basic Rating Life (L_{10}) of at least 80,000 hours unless otherwise indicated in the fan product section. All bearings shall be factory lubricated and equipped with standard hydraulic grease fittings and lube lines extended to the motor side of the fan.

K. All belt-driven drive assemblies shall be factory mounted, with final alignment and belt adjustment made after installation. Fan shafts shall be turned, ground and polished steel and keyed to wheel hub. Fan Pulleys shall be Cast iron with split, tapered bushing and dynamically balanced at factory. Motor Pulleys shall be adjustable pitch. Select motor pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Belts shall be oil resistant, nonsparking, and nonstatic with matched sets for multiple belt drives. Motor mounts shall have an adjustable base. Fan and motor shall be isolated from the exhaust air stream unless otherwise indicated.

L. All V-belt drives shall be designed for 150% of motor rating.

M. For direct drive fans with VFDs and bypass starter, select fan to operate at or above the fan's motor speed to allow fan operation in bypass mode.

N. Provide stainless steel fasteners to secure fan to curb.

O. Provide solid state speed controller (SCR) with PSC motor or electrically commutated motors (ECM) for all direct drive fans with single phase motors.

P. Provide backdraft or motorized dampers for fans where required by the plans or specifications. .

Q. Exhaust fans and attachments to structure shall be designed to conform with the wind and seismic structural loading requirements identified in "Performance Requirement".

R. Forward curved fans may be provided when scheduled and when static pressure differential at fan is 1.5" W.G. or less.

PART 2 - PRODUCTS

2.1 UTILITY SET FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ACME Engineering & Mfg. Corp.
2. Central Blower Company
3. Carnes Company
4. Greenheck Fan Corporation
5. Loren Cook Company
6. New York Blower Company
7. Peerless
8. PennBarry
9. Twin City Fan

B. Description: Single-width, single inlet direct- or belt-driven centrifugal fans consisting of rotatable housing, wheel, fan shaft, bearings, motor, starter and disconnect switch, drive assembly, and accessories.

C. Housing: Fabricated of steel coated with electrostatically applied baked polyester urethane with side sheets fastened with air tight lock formed seams or welded to scroll sheets with inlet cone. Belt guards or weather hood for exterior applications.

1. Housing Discharge Arrangement: Adjustable to eight standard positions.

D. Fan Wheels: Single-width, single inlet non overloading aluminum or steel air foil or backward inclined blades secured to backplate.
1. Spark-Resistant Construction: AMCA 99, Type A.

E. Accessories:

1. Inlet and Outlet: Flanged.
2. Companion Flanges: Rolled flanges for duct connections of same material as housing.
3. Access Door: Gasketed door in scroll with latch-type handles.
4. Drain Connections: NPS 3/4 threaded coupling drain connection installed at lowest point of housing.
5. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment for exterior applications.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor and efficiency requirements for motors as specified in Common Motor Requirements for HVAC equipment specifications.

B. Single phase motors to include integral thermal overload protection.

2.3 ELECTRICAL

A. Fans shall be supplied with NEMA motor controllers, means of disconnect and overcurrent protection in accordance with mechanical, control and electrical specifications.

B. Disconnect Switch: Nonfusible type factory mounted. Locate within motor compartment for exterior applications, factory wired to motor.

C. Furnish each variable speed three phase motor with field mounted variable frequency drive, VFD, with bypass, circuit breaker or fused disconnect switch, transformers, and all necessary motor starter, contactor and overcurrent protection. Locate remotely in an enclosed location for exterior applications.

D. Furnish each constant speed three phase motor with field mounted fusible combination motor starter/disconnect switch, transformers, and all necessary motor starter, contactor and overcurrent protection. Locate remotely in an enclosed location for exterior applications.

E. Direct Drive Speed Controller – Manually adjustable type for constant volume operation and automatic modulating or two speed type for automatic control suitable for PSC or ECM single phase motors.

2.4 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Compliance: In accordance with approved submittals and manufacturer’s written installation instructions.

B. Comply with mounting and anchoring requirements for seismic and/or wind installations.

C. Secure fan and curb mounting assemblies to structure with positive attachments in accordance project’s seismic loading requirements.

D. Secure exterior fans and curb mounting assemblies to structure with positive attachments in accordance with project’s seismic and/or wind loading requirements.

E. Install roof-mounting units on concrete bases with vibration isolation per specifications.

F. Secure roof-mounting fans to roof curbs with stainless or cadmium-plated hardware. Install units with clearances for service and maintenance. In no case, shall the access and service space around and over fans less than that recommended by manufacturer.

G. Install work readily accessible for normal operation, reading of instruments (in vertical position), adjustment, service, inspection and repair. Provide access panels where indicated and required. Access panels shall be the responsibility of the respective subcontractor.

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Install ducts adjacent to fans to allow service and maintenance.

B. For fans with drain, install a drain valve with screwed cap.

C. Provide internal wiring conduits so that all electrical and control wiring penetrates the building envelope within the interior of the roof curb to eliminate exposed wiring and conduit.

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete.
3. Verify that thermal-overload protection is provided for motors.
4. Verify that cleaning and adjusting are complete.
5. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
6. Adjust belt tension.
7. Adjust damper linkages for proper damper operation.
8. Verify lubrication for bearings and other moving parts.
9. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
10. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
11. Shut unit down and reconnect automatic temperature-control operators.
12. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain fans.

3.5 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Replace fan and motor sheaves as required to achieve design airflow. After system is balanced, replace the variable pitch sheaves with fixed pitch sheaves.

D. Lubricate bearings.

END OF SECTION

SECTION 23 36 16 –AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. Single-duct air terminal units (with or without reheat).
   2. Dual-duct air terminal units.

B. Related Sections include the following:

   1. Division 23 Section "Seismic Restraint For HVAC Piping and Equipment" for requirements necessary for compliance with seismic criteria.

1.3 PERFORMANCE REQUIREMENTS

A. Products shall be suitable for the indicated service including piping system fluids, materials, pressures, and temperatures.

B. Hydronic coils and installation shall withstand the minimum design pressure and temperature and test pressure as specified in Division 23 Section “Hydronic Piping.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories. Provide power, signal and control wiring diagrams.

   1. Air terminal units.
   2. Liners and adhesives.
   3. Sealants and gaskets.

B. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work.

   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Wiring Diagrams: For power, signal, and control wiring.
3. Hangers and supports, including methods for duct and building attachment and vibration isolation

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification: Manufacturer's certification of seismic qualification according to ASCE 7. Submit ASCE 7 special seismic certification as required. Include method used to determine compliance with requirements.

1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air terminal units to include in operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan-Powered-Unit Filters: Furnish one spare filter for each filter installed

1.8 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air terminal units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. NFPA Compliance: Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

1.9 DESIGN CRITERIA

A. Where any of the air terminal devices in this section are indicated on the drawings to control space conditions in conjunction with a reheat coil, that reheat coil may be furnished as an integral part of or standard accessory to the devices specified below.

B. Unless otherwise stated, construct unit casings of galvanized steel or aluminum meeting SMACNA or ASHRAE Standards. Insulate casings thermally and acoustically with insulation meeting requirements of NFPA 90A and UL-181.

C. Unless otherwise stated, units shall be pressure independent and maintain air volume within plus or minus 5% at all flow rates within its published capacity range regardless of systems air pressure.

D. All casings located downstream of high efficiency particulate air filters shall not be internally insulated. Provide units with necessary sound attenuators constructed of all metal as required to meet the sound requirement specified.

E. The air terminal device manufacturer, or his designated representative, will be required to verify the air terminal device performance and adjust or replace the device within the warranty period when it is determined that a problem exists in the area served by the device.

F. The actuator and its controller shall be calibrated and factory set for the scheduled air flow rates. Units shall be capable of field calibration and readjustment with external gauge taps.

G. Units shall be capable of operating from the minimum inlet static pressure scheduled to 4 inches W.G. without exceeding NC 35. Provide sound attenuators as required to meet this requirement, whether the attenuators are specified or not.

H. Primary air volume damper sections shall not require periodic maintenance and shall be calibrated at the factory according to the schedule shown on the plans.

I. Sound ratings shall be derived from sound power levels as measured in accordance with ASHRAE Standard 36-72, with a reference level of 10-12 watts, and rated at NC levels with an 8 db room attenuation reduction.

1.10 COORDINATION

A. Coordinate layout and installation of air terminal units and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies. Coordinate location of ceiling access panels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SINGLE-DUCT AIR TERMINAL UNITS (WITH OR WITHOUT REHEAT)

A. Manufacturers:

1. Anemostat
2. Carrier
3. Enviro-Tec
4. Greenheck Fan Corporation
5. Krueger.
6. METALAIRE, Inc.; Metal Industries Inc.
7. Nailor Industries Inc.
8. Price.
9. Titus.
10. Trane.

B. Configuration: Volume-damper assembly inside unit casing with control components located inside a protective metal shroud.

C. Casing: 0.034-inch steel.

1. Casing Lining: 1/2-inch-thick, coated, fibrous-glass duct liner complying with ASTM C 1071; secured with adhesive. Cover liner with nonporous foil.
2. Casing Lining: Adhesive attached, 3/4-inch-thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
3. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
4. Air Outlet: S-slip and drive connections.
5. Access: Removable panels for access to dampers and other parts requiring service, adjustment, or maintenance; with airtight gasket.
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

D. Regulator Assembly: Extruded-aluminum or galvanized-steel components; key damper blades onto shaft with nylon-fitted pivot points located inside unit casing.

1. Automatic Flow-Control Assembly: Combined spring rates shall be matched for each volume-regulator size with machined dashpot for stable operation.
2. Factory-calibrated and field-adjustable assembly with shaft extension for connection to externally mounted control actuator.

E. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: ARI 880 rated, 3 percent of nominal airflow at 3-inch wg inlet static pressure.
2. Damper Position: Normally open.

F. Access: Access shall be provided to the control damper and operator via a removable panel. Access panel shall allow adjustment and replacement of control damper and operator when installed internally. Provide adequate accessibility when control damper with operator is field installed.

G. Hot-Water Heating Coil: Copper tube, mechanically expanded into aluminum-plate fins; factory installed.

1. Coil tubes shall be 0.016-inch thickness
2. Coils shall be leak tested underwater to 300 psig.
3. Number of coil rows and circuits shall be provided as required to meet the capacities as listed on the plan schedules.

H. Controls: Refer to Division 23 Section – “Instrumentation and Control for HVAC” and related Division 23 sections for control requirements, including sequence of operations.

I. Electronic Controls:

1. Electronic Damper Actuator: 24 V, spring-return open.
2. Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.
3. Electronic Air Volume Controller: Pressure-independent analog electronic controller, factory calibrated and field adjustable to minimum and maximum air volumes; provides consistent airflow to the space in response to electronic thermostat signal while compensating for inlet static-pressure variations of up to 4 inches wg; includes a multipoint velocity sensor at air inlet.

2.3 DUAL-DUCT AIR TERMINAL UNITS

A. Manufacturers:

1. Anemostat
2. Carrier
3. Enviro-Tec
4. Greenheck Fan Corporation
5. Krueger.
6. METALAIRE, Inc.; Metal Industries Inc.

7. Nailor Industries Inc.
8. Price.
9. Titus.
10. Trane.

B. Configuration: Two volume dampers inside unit casing with mixing attenuator section and control components located inside a protective metal shroud.

C. Casing: 0.034-inch steel.

1. Casing Lining: 1/2-inch-thick, coated, fibrous-glass duct liner complying with ASTM C 1071; secured with adhesive. Cover liner with nonporous foil.
2. Casing Lining: Adhesive attached, 3/4-inch-thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
3. Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
4. Air Outlet: S-slip and drive connections.
5. Access: Removable panels for access to dampers and other parts requiring service, adjustment, or maintenance; with airtight gasket.
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: ARI 880 rated, 3 percent of nominal airflow at 3-inch wg inlet static pressure.
2. Damper Position, Hot Deck: Normally [**open**] [**closed**].
3. Damper Position, Cold Deck: Normally [**closed**] [**open**].
4. Damper Position, Ventilation Deck: Normally [**closed**] [**open**].

E. Access: Access shall be provided to the control damper and operator via a removable bottom panel. Access panel shall allow adjustment and replacement of control damper and operator when installed internally. Provide adequate accessibility when control damper with operator is field installed.

F. Controls: Refer to Division 23 Section – "Instrumentation and Control Devices for HVAC" and other relates controls sections for control requirements, including sequence of operations.

2.4 SOURCE QUALITY CONTROL

A. Identification: Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

B. Verification of Performance: Rate air terminal units according to ARI 880. Rate hot water coils in accordance with ARI 410.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

B. Comply with mounting and anchoring requirements for seismic installations.

C. Temporary labeling: Mark underside of terminal unit with unit ID with permanent marker until permanent labels are applied.

3.2 START-UP, CALIBRATION AND FIELD TESTING LABORATORY TERMINAL UNITS

1. All instruments shall be calibrated and records shall be kept of the associated calibration.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air terminal units to allow service and maintenance.

C. Hot water piping: In addition to requirements in Division 23 Section "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange. Refer to plan details for additional information.

D. Connect ducts to air terminal units according to Division 23 Section "Metal Ducts" and "Nonmetal Ducts."

E. Ground units with electric heating coils according to Division 26 Section "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections for all airflow control valves. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: For fan powered unit, after electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 23 37 13 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Ceiling diffusers.
2. Registers and Grilles
3. Operating room ceiling diffusers.

B. Related Sections:

1. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.
2. Division 23 Section “HVAC Insulation” for insulation of supply plenums.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.4 DESCRIPTION

A. All diffuser and register locations in ceilings and walls shall be coordinated with reflected ceiling plans and electrical and low voltage plans prior to submittal and installation.

B. Prior to submitting diffusers, registers and grilles to for review, and prior to ordering, verify the ceiling system and type of ceilings specified in each space and coordinate the air device mounting system and frame with the ceiling type indicated on the reflected ceiling plans in the architectural plan documents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers for specialty products are listed under those articles. For all other diffusers, registers and grilles available manufacturers are as follows:

1. Anemostat.
2. Hart and Cooley, Inc.
3. Kreuger
4. METALAIRE, Inc.
5. Nailor Industries Inc.
6. Price Industries.
7. Titus.
8. Tuttle and Bailey.

2.2 CEILING DIFFUSERS

A. Construct diffusers of aluminum unless otherwise indicated, and provide with the frame type appropriate to the installation.

B. Provide diffusers with air straighteners.

C. Perforated face ceiling diffusers shall have field adjustable pattern controllers accessible through a removable or hinged face plate.

D. Furnish round or square neck duct adapters for each unit for top connection or side connection as appropriate to the space.

E. Accessories:

1. Equalizing grid.
2. Plaster ring.
3. Safety chain.
4. Wire guard.
5. Sectorizing baffles.
6. Operating rod extension.
7. Opposed blade volume dampers.

F. Diffuser models, sizes and finishes shall be as shown on the plans and/or as scheduled. Unless noted otherwise, diffusers shall have a baked enamel finish with color to be selected by the Architect.

2.3 REGISTERS AND GRILLES

A. Construct registers and grilles of aluminum unless otherwise indicated, and provide with the frame type appropriate to the installation.

B. Supply registers and grilles shall be double deflection type blades to provide for air deflection adjustment in all directions.

C. Return and exhaust registers and grilles shall have a core of fixed blades.

D. Furnish supply grilles complete with opposed blade volume control dampers, operable from the face.

E. Register and grille models, sizes and finishes shall be as shown on plans and/or as scheduled. Unless noted otherwise, registers and grilles shall have a baked enamel finish with color to be selected by the Architect.

2.4 OPERATING ROOM CEILING DIFFUSERS (CATH LAB SPACES)

A. Panels shall be aluminum construction consisting of framing, valve mechanism and perforated distribution plate.

B. Valve mechanism shall be accessible through the distribution plate which shall be removable for cleaning.

C. Furnish panels for round or rectangular duct connections as indicated on the drawings.

2.5 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in

lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

D. Blank-off unused portion of linear diffusers and grilles.

E. Coordinate border and frame type with Architectural Plans.

F. For return grilles open to a ceiling plenum provide insulated sound boot behind grille for sound control and to prevent above ceiling utilities from being visible from the occupied space.

END OF SECTION

SECTION 23 41 00 - AIR FILTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes factory-fabricated air-filter devices and media used to remove particulate matter from air for HVAC applications.

1.3 DEFINITIONS

A. HEPA: High-efficiency particulate air.

B. ULPA: Ultra low penetration air.

C. MERV: Minimum Efficiency Reporting Value per ASHRAE 52.2

D. Efficiency: Dust Spot Efficiency per ASHRAE 52.1.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of filter and rack to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide one complete sets of filters for each filter bank.

2. Provide extra set of filters for each filter bank. The extra sets of filters are in addition to the filters replaced prior to owner occupancy.

1.7 QUALITY ASSURANCE

A. Comply with applicable requirements in ASHRAE 62.1.

B. Provide MERV rated filters which comply with ASHRAE 52.2 for method of testing and rating air-filter units.

C. Comply with NFPA 90A and NFPA 90B.

1.8 DELIVERY, STORAGE AND HANDLING

A. Protect filters, housings, accessories and finishes from damage during shipping, storage, handling and installation. Deliver materials to the site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

B. The Contractor shall provide for storage in an enclosed trailer, when stored on-site and prior to building "dry-in", to prevent any damage resulting from inclement weather or construction traffic.

C. Materials, stored or installed, found to be damaged shall be replaced with new by the Contractor, to the satisfaction of the Owner and at no additional cost to the owner.

1.9 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.10 DESIGN CRITERIA

A. Holding frames or housings specified in this Section may be furnished by the filter manufacturers listed below, or where applicable, as part of the factory packaged air handling units.

B. Filter holding frames shall accept Manufacturer's standard filter sizes. Systems which utilize custom size filters will not be acceptable.

C. Filter holding frame gaskets suitable for type filters utilized to control bypass of unfiltered air.

D. Refer to schedules on the drawings for specific filter applications, efficiencies, capacities and characteristics.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Description: Factory-fabricated, media type filters and filter housings.

B. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. AAF International.
2. Camfil Farr.
3. Flanders/CSC Corp.
4. Tri-Dim Filter Corporation.
5. Purafil, Inc.

C. Refer to individual product sections for additional specific manufacturers.

2.2 MEDIUM EFFICIENCY PLEATED FILTERS

A. Description: MERV 8 (30%) efficiency, factory-fabricated, self –supported, extended-surface, pleated, panel-type, UL 900 listed disposable air filter with holding frames.

B. Media: Interlaced cotton and synthetic fibers with nonflammable adhesive and anti-microbial agent application.

1. Separators shall be bonded to the media to maintain pleat configuration.
2. Welded wire grid treated for corrosion resistance on 1” centers bonded to media on downstream side to maintain pleats.
3. Media bonded to frame to prevent air bypass.

C. Frame: Rigid, high wet-strength cardboard frame with diagonal support members bonded to air entering and air leaving side of pleats to maintain pleat spacing. .

D. Filters shall be 1”, 2” or 4” thick MERV 8 as scheduled.

E. 2” and 4” thick filters, clean pressure drop not to exceed .31” at 500 fpm. Maximum air velocity rating of 600 fpm.

F. 1” thick filters, clean pressure drop not to exceed .25” at 350 fpm. Maximum air velocity rating of 425 fpm.

G. Rated to withstand a differential pressure up to 2.0” WG.

2.3 MEDIUM AND HIGH EFFICIENCY EXTENDED MEDIA RIGID FILTERS

A. Description: MERV 11 to MERV 16 (60% to 95%) efficiency, factory-fabricated, self – supported, extended-surface, deep pleated, rigid panel-type, UL 900 listed disposable air filter with holding frames. High efficiency filters are filters rated MERV 14 and above.

B. Media: Laminated microfine glass fibers with reinforcing backing with nonflammable adhesive and anti-microbial agent application.

1. Separators shall be bonded to the media to maintain pleat configuration.
2. Media mechanically and chemically bonded to frame to prevent air bypass.

C. Frame: Rigid, high wet-strength cardboard frame with diagonal support members bonded to air entering and air leaving side of pleats to maintain pleat spacing

D. MERV 11 filters shall be 4” thick or as scheduled.

1. MERV 11 filters selected for a clean pressure drop less than 0.3” at 500 fpm, unless scheduled otherwise.
2. Rated to withstand a differential pressure up to 2.0” WG

E. MERV 13 filters shall be 12” thick or as scheduled.

1. MERV 13 filters selected for a clean pressure drop less than 0.5” at 500 fpm, unless scheduled otherwise.
2. Rated to withstand a differential pressure up to 5.0” WG

F. MERV 14 and above filters shall be 12” thick or as scheduled

1. MERV 14 filters selected for a clean pressure drop less than 0.7” at 500 fpm, unless scheduled otherwise.
2. Rated to withstand a differential pressure up to 5.0” WG

G. Filters rated to operate up to 600 fpm.

2.4 FILTER GAGES

A. Description: Diaphragm type air pressure differential gage with pointer, adjustable signal flag, maximum pressure limit to plus or minus 15 “ WG, over pressure relief and zero adjustment.

1. Housing: Die cast aluminum case and bezel with acrylic cover.
2. Size: 4” (102 mm) dial face.
3. Range:

a. Pre-filters and less than MERV 9 0- to 1.0-inch wg
b. MERV 9 and above including Final Filters and HEPA Filters 0- to 2.0-inch wg.

4. Accuracy: Plus or minus 3 percent of full scale.

B. Basis-of-Design Product: Subject to compliance with requirements, provide product Dwyer Instruments, Inc. Series 2000 Magnehelic or comparable product by one of the following:

1. Airguard Industries, Inc.

C. Accessories: Air filter kit with static-pressure tips, ¼" O.D. aluminum tubing, gage connections, 3 way vent valves, mounting bracket and weatherproof enclosure for exterior applications. Provide flush mounting kit when indicated on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Inspect areas where material is to be installed. Notify the Architect of conditions which would adversely affect the installation or subsequent utilization of filters. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install filters and filter housings at locations indicated and/or specified according to manufacturer's written instructions.

B. Position each filter housing with clearance for normal service and maintenance.

C. Install filters in position to prevent passage of unfiltered air.

D. For air handling systems greater than 2000 CFM, provide separate filter gage for each filter in system. This included the pre-filter and any medium efficiency, or high efficiency filters. Provide filter gage for pre-filters installed in factory air handling equipment.

E. Install filter gage static-pressure tips upstream and downstream from filters to measure pressure drop through filter. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Adjust, level and calibrate gages.

F. Coordinate filter and filter housing installations with ductwork, equipment, controls and associated work.

G. Mark each filter gage with dirty filter mark and set signal flag to inform maintenance personnel when to change filters.

H. Install filter media upon installation of equipment. Upon start up of systems, Contractor shall monitor filter pressure loss and replace media as required for the duration of construction.

3.3 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION

SECTION 23 73 14 - CUSTOM OUTDOOR AIR HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Constant-air-volume and variable air volume air-handling units designed for outdoor mounting.
2. Return fan, dehumidification wheel, economizer, filters, supply fan, heating coils, humidifier, sound attenuator and cooling coil sections as shown on the plans and/or scheduled.

B. Related Sections include:

1. Division 23 Section "Seismic Restraint for HVAC".
2. Division 23 Section “Common Motor Requirements for HVAC Equipment”.
3. Division 23 Section “Vibration Controls for HVAC”.
4. Division 23 Section “Control Sequence”.
5. Division 23 Section “Air Filters”.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance:

1. Casing panels shall be self-supporting and withstand static pressures of +8” W.G. in all positive pressure sections and -8” W.G. in all negative pressure sections, without panels exceeding a deflection of L/240. Where "L" is the unsupported panel span length: height of the unit on the sides, width of the unit on top and the smaller of width or height for the ends.
2. Floor panels shall additionally be designed to support a 300 pound load during maintenance activities without floor panels exceeding a deflection of L/240.

B. Casing Leakage: The casing leaking rate shall not exceed a leakage class 6 (C_L=6). Maximum leakage at +8” W.G. and -8” WG for C_L = 6 is (C_LX $P^{0.65}$ = .23 CFM / square foot).

C. Structural Attachment Forces: As determined from wind design pressures using actual equipment dimensions calculated per the structural wind loading requirements of the Building Code.

D. Seismic Performance: AHU units, components and mounting assemblies shall withstand the effects of seismic forces in accord with project Seismic specifications.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Include rated capacities, furnished specialties and accessories for each AHU.
2. Unit dimensions, weight and appropriate identification.
3. Cabinet material, metal thickness, finishes, insulation, vibration isolation, and accessories.
4. Panel deflection and casing leakage identified in “Performance Requirement” article.
5. Fans:

   a. Certified fan-performance curves with system operating conditions indicated. Fan curves shall include a series of curves indicating the relationship of CFM and static pressure for various RPM. Brake horsepower curves shall also be included. Indicate the design operating point clearly on the fan curves. Indicate fan brake horsepower requirement at the design operating point.
   b. Certified octave band unit fan sound power levels at duct connections.
   c. Fan construction and accessories.
   d. Motor ratings, RPM, electrical characteristics, and motor accessories.
   e. For units with multiple parallel fans, provide fan curves showing performance of all operating fans in parallel, performance of a single operating fan and performance of all fans less one operating fan.

6. AMCA certified outside air and exhaust air louver performance ratings indicating manufacturer, model, air flow, pressure drops, water penetration and accessories.
7. Roof curb.
8. Data for factory furnished motor controllers and/or integral controls in accordance with Control Systems specifications and Division 26.
9. Certified coil-performance ratings with system operating conditions indicated.
10. Certified energy recovery and dehumidification wheel cross-flow, carryover and purge air flow rates at design operating conditions indicated.
11. Dampers, including housings, linkages, and operators.
12. Filters with performance characteristics.

B. Shop Drawings:

1. Include plans, elevations, sections and attachment details.
2. Detail equipment assemblies and indicate dimensions, weights, load distribution, required clearances, method of field assembly, components, and location and size of each field connection.
3. Wiring Diagrams: For power, signal, and control wiring. Factory-installed and field installed wiring shall be clearly indicated.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification: Manufacturer's certification of seismic qualification according to ASCE 7. Submit ASCE 7 special seismic certification as required. Include method used to determine compliance with requirements.

1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-handling units to include in operation and maintenance manuals. Include startup service reports and special warranty.

1.7 QUALITY ASSURANCE

A. NFPA Compliance: Comply with NFPA 90A and 90B.

B. National Electric Code: Comply with NFPA 70.

C. AHRI Rating:

1. Air-handling units and their components rated according to AHRI 430.
2. Air handling unit cooling and heating capacity, selected and rated in accordance with AHRI 410.
3. Air handler sound levels determined and rated in accordance with AHRI 260.
4. Air-handling air-to-air energy recovery equipment capacity and air leakage, selected and rated in accordance with AHRI 1060.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases and/or structural-steel support members with actual equipment provided.

B. Coordinate sizes and locations of roof curbs and roof penetrations with actual equipment provided.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of air-to-air energy recovery equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period for AHU motors and coils: 6 years from date of startup.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set of additional pre-filters and one set of additional final filters for each air-handling unit in accordance with Air Filter specifications. These are in addition to the filters installed before owner occupancy.
2. Fan Belts: One set(s) for each belt driven fan.

1.11 DESIGN CRITERIA

A. The air handling unit shall be specifically designed for mounting in an outdoor application: curb or pedestal mounting as indicated on the drawings. The air handling unit and attachments to structure shall be designed to conform with the seismic structural loading requirements identified in “Performance Requirement”.

B. Furnish units complete with fans, motors, belt drives, coils, drain pans, filter sections, adjustable frequency drives, economizers, dampers, access doors and access sections as shown on the plans and/or as scheduled. Maximum coil velocity, air pressure drop, and water pressure drop shall not exceed scheduled requirements.

C. Units shall have the configuration and meet capacity as indicated on the plans and/or as scheduled.

D. Air handling units shall be provided with all necessary tags and decals to aid in the service and/or indicate caution areas. Electrical wiring diagrams shall be attached to the control panel access door. Lifting lugs shall be supplied to facilitate rigging of the air-handling unit.

E. Each fan shall be selected to maintain stable fan performance at 90% of the scheduled air flow while operating at 110% of the scheduled static pressure.

F. Each fan and motor combination shall be selected to allow full speed operation: deliver 110% of the air quantity scheduled at 121% of the scheduled static pressure. Provide Class I, II, or III fan construction as defined by AMCA for full speed operation of 110%, minimum, design RPM. Unit static pressure shall take into consideration the actual static pressure loss of the components furnished within the unit including operation with dirty filters. The motor furnished with the fan shall not operate into the motor service factor in any of these cases. Drive efficiency shall be considered in motor selection according to manufacturer's published recommendation, or according to AMCA.

G. Where inlet and outlet ductwork at any fan is changed from that shown on the drawings, submit a scaled layout of the change and system effect factor calculations, indicating increased static pressure requirement as described in AMCA Publication 201. This Contractor shall be responsible for any motor, drive and/or wiring changed required as a result of duct configuration changes at the fan.

H. Air handling unit shall be supplied to meet the maximum octave band sound power levels at duct connections scheduled. Sound ratings shall be in strict compliance with the latest AHRI 260 Standard.

I. Provide inverter duty motors with shaft grounding devices with Variable Frequency Drives or EC motors for variable fan speed applications. Comply with additional requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

J. Provide unit with manufacturer's standard finish except where custom color is required by the documents. The finished unit shall exceed 500-hour salt spray test in accordance with ASTM B-117.

K. When using curb to attach air handler to structure, provide stainless steel fasteners and/or clips to secure AHU to curb.

L. Provide shipping splits and demounts as necessary for project constraints.

M. Discharge and inlet plenum connections sized at over 1200 FPM shall have bell mouth duct fittings with a 6" minimum radius.

N. Forward curved fans may be provided when scheduled and when total static pressure differential at fan is 2.5" W.G. or less.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: provide product indicated on schedule as PACE™ Outdoor by Johnson Controls Inc. (Must have Seismic Certification)

B. Alternately, provide product, subject to compliance with requirements, by one of the following:

1. Daikin Applied Custom
2. Trane Performance Climate Changer, Model CSAA
3. Temtrol Model ITF
4. Approved Equal

2.2 GENERAL DESCRIPTION

A. Air Handling Unit(s) (AHU) shall consists of a structural base, insulated casing, access doors, fans, motors, motor controls, coils, filters, dampers, controls, components, and accessories.

B. Provide AHU to meet the specified levels of performance for scheduled items including airflow, static pressure, cooling capacity, heating capacity, electrical characteristics, sound, casing leakage, panel deflection and casing thermal performance.

C. AHU shall maintain structural integrity when wall panels are removed.

D. Provide internal components and accessories as specified and scheduled. Components and accessories shall be installed by the AHU manufacturer in an ISO-9002 certified facility.

E. Unit[s] shall be ship in one piece. Split unit(s) only where necessary for shipping and installation.

F. Manufacturer shall provide detailed, step-by-step instructions for disassembly and reassembly.

G. For AHU segments that must be broken down for rigging and installation: segment shall be disassembled and reassembled by manufacturer's factory-trained service personnel.

H. Manufacturer shall perform a field leakage test to confirm 1% maximum leakage per Section 2.27. Manufacturer shall provide a written statement confirming that the unit is built to the manufacturer's factory standards and that the unit will carry the full warranty.

2.3 STANDARDS COMPLIANCE

A. Manufacturer shall comply with ratings and certifications referenced in this specification.

B. Manufacturers who do not comply with ANSI/AHRI-430 shall factory test EACH unit to verify brake horsepower rating, airflow performance and total static pressure performance. See specification Section 2.27 (VERIFICATION OF PERFORMANCE) for testing requirements.

C. Manufacturers who do not conform to requirements of AHRI 260 for ducted discharge and return air sound shall submit EACH unit to an independent sound test laboratory for AHRI 260 testing. The test laboratory shall conform to AHRI 260, Section 4.4, Test Equipment and Facilities.

2.4 BASE RAIL

A. Unit(s) shall be provided with structural base rail under the full perimeter of the unit, formed from mill galvanized steel.

B. Structural steel shall be installed providing clearance for proper external trapping of drain pans and steam condensate.

C. Unit(s) shall be provided with base rail and lifting lug system that does not require additional support for rigging. Include base rail lifting lugs at unit corners.

2.5 CASING

A. Casing construction shall not rely on the casing panels for structural integrity.

B. Casing panels shall be 2" double-wall construction with thermal break. Thermal break shall be between interior and exterior liner of the panel assembly, and between the panel and casing framework.

C. Provide casing with minimum thermal resistance (R-value) of 16 hr-ft2-°F/BTU. Exposed insulation is not acceptable.

D. Casing panel insulation shall be injected polyurethane foam. Foam insulation shall be manufactured by EcoMate®. Rigid foam board panels shall not be used.

E. Casing framework downstream of cooling coil shall be filled with injected polyurethane foam insulation. Foam insulation shall be manufactured by EcoMate®.

F. Casing panels with perforated interior liners (perforated panels) shall be provided where indicated on the drawings and/or schedule. Perforated panels shall be a hybrid combination of 1" fiberboard and 1" injected polyurethane foam. Foam insulation shall be manufactured by EcoMate®. Rigid foam board panels shall not be used. Minimum perforated panel thermal resistance (R-Value) shall be R13 hr-ft2-°F/BTU.

G. All exterior and interior casing panels (roof, wall, floor, access door) shall be made of G90 galvanized steel.

H. Panel assembly shall meet UL standard 1995 for fire safety. Panel insulation shall comply with the requirements of NFPA 90A.

I. Insulation system provided shall be resistant to mold growth in accordance with a standardized test method such as UL 181 or ASTM C 1338.

J. Encapsulate insulation with sheet metal so that air does not contact insulation. Solid lined double-walled panels insulated with injected foam shall be hermetically sealed at each corner and around their entire perimeter to eliminate airflow through the panel and to eliminate microbial growth potential within the casing wall.

K. Unit shall conform to ASHRAE Standard 111 Class 6 for casing leakage no more than 1% of design airflow at 1.25 times design static pressure up to a maximum of +8 inches w.g. in positive pressure sections and -8 inches w.g. in negative pressure sections down to a minimum of 50 CFM measurable leakage or 5,000 design CFM.

L. Provide wall panels and access doors that deflect no more than L/240 when subjected to 1.5 times design static pressure up to a maximum of +8 inches w.g. in positive pressure sections and -8 inches w.g. in negative pressure sections. 'L' is the panel-span length and 'L/240' is the deflection at panel midpoint.

M. Provide floors and roofs that deflect no more than L/240 when subjected to a 300 lb static load at mid-span. 'L' is the panel-span length and 'L/240' is the deflection at panel midpoint.

N. Provide outdoor AHUs with a roof system that deflects no more than L/240 when subjected to a static snow load of 30 lb./ft2. 'L' is defined as the panel-span length and 'L/240' is the deflection at the panel midpoint.

O. Condensation shall not form anywhere on unit exterior at 52 supply air and 95 DB / 75 WB exterior ambient. Manufacturer shall supply an external condensation performance line, plotted on the psychrometric chart, based on actual test data. Plot will show the exterior conditions at which unit will sweat given the design supply air temperature. Manufacturer shall clearly indicate whether the design conditions will or will not result in external condensation forming anywhere on the unit exterior. If the unit will sweat, indicate where sweating will occur. Unit exterior includes the base, base rail, roof, corners, doors, door frames, and under the cooling coil drain pan."

2.6 ROOF SYSTEM

A. Roof system outer layer

1. Shall have no points of penetration.
2. Shall use no fasteners.
3. Shall have no metal-to-metal seams joints.
4. Shall not use or require caulking.

B. Roof system shall be sloped with a minimum pitch of 1/8" per foot.

C. Roof system shall overhang side and end panels by a minimum of 2."

D. Doors shall have drip edge guard above door frame. Drip edge guard shall extend 2" beyond door surface.

E. Field connection at roof of section splits shall not require use of fasteners, sealants or metal seam caps.

2.7 ACCESS DOORS

A. Provide double wall access door(s) that meet requirements for the AHU casing.

B. Thermal break door(s) shall incorporate a thermal break in both the door frame and the door panel.

C. Provide industrial-style stainless steel hinges that permit 180 degrees of door swing.

D. Provide latches with roller cam mechanisms that ensure a tight seal. Rotating knife-edge or "paw" latches are not acceptable.

E. Provide each door with a single handle linked to multiple latching points or a separate handle for each latching point. Doors serving access segments shall have an interior latch handle.

F. Provide access doors with a locking hasp to accommodate a lockout device.

G. Provide double-pane viewing windows. Windows shall be a non-condensing type consisting of a desiccant dehumidification layer. Minimum dimension shall be 3” x 8”.

2.8 COILS: HEATING AND COOLING

A. Coils shall meet or exceed performance scheduled on drawings.

B. Coils shall be provided with performance certified in accordance with AHRI Standard 410 for coil capacity and pressure drop, wherever applicable. Coils circuits shall be designed such that the fluid velocity is within the range of certified rating conditions at design flow.

C. Cooling coils shall be provided with a maximum face velocity as scheduled. Face velocity calculations shall be based on the finned area of the coil.

D. Cooling coil shall be provided with drain pan that is sufficient to contain coil condensate. Drain pan shall extend a minimum of 10” downstream of the face of the coil.

E. Coil segment casing shall accommodate full-face or reduced-face coils as scheduled. Face and bypass coil segments shall be provided with factory installed bypass damper.

F. Access shall be provided of at least 24” between coils. Access panel or door shall be easily operable and are easily removable with no special tools, as shown on drawings.

G. Access doors shall be located to provide clearance for pipe insulation, connectors, and accessories. Space shall allow a minimum of 90 degrees of door swing.

H. Coils shall be built in their own full perimeter frame. Tube sheets on each end shall have fully drawn collars to support and protect tubes. Horizontal coil casing and support members shall allow moisture to drain. Casing and support members shall not block finned area.

I. Individual coils shall be removable from the side of the AHU.

J. Intermediate drain pan shall be provided on stacked cooling coils. Intermediate drain pan shall slope in a minimum of two planes toward a single drain connection.

K. A single intermediate vertical coil support shall be provided on coils with a finned length greater than 62”.

L. Staggered Coil bank shall be provided. Each connection shall be provided with 1/4" FPT plugged vent/drain tap. Circuiting shall allow draining and venting when installed. Vent, drain, and coil connections through AHU casing shall be extended.

M. Gap between coil stub out connection and AHU casing, shall be insulated with a spool-shaped sleeve grommet. Adhesive rings applied to the casing walls shall not be acceptable.

N. Direct expansion (DX) coils shall conform to UL-207, "Standard for Safety: Refrigerant – Containing Components and Accessories, Nonelectrical," when operating with a maximum refrigerant pressure of 325 psig. Factory shall test DX coils with 325 psig compressed air under water. DX coils shall be dehydrated and sealed prior to installation.

O. Coils shall be provided with a tube OD of 1/2" or 5/8". Mechanically expand tubes shall form fin bond and provide burnished, work-hardened interior surface.

P. DX coils shall be provided with brass distributor and solder-type connections. Suction and discharge connections shall be on the same end regardless of coil depth. DX coils shall be provided with a hot gas bypass port on distributor.

Q. Continuous aluminum or copper fins shall be provided for coils with die-formed fins. Fins shall have fully drawn collars to accurately space fins and protect tubes. Fins shall be 0.006" or 0.008 or 0.01" thick.

2.9 PRIMARY DRAIN PANS

A. Unit(s) shall be provided with a drain pans under each cooling coil and humidifier.

B. Provide drain pan under the complete width and length of cooling coil and humidifier sections. Drain pan shall be full width, and extend a minimum of 6" downstream of cooling coil.

C. Drain pans for cooling coils and humidifiers shall meet the requirements of ASHRAE 62.

D. Drain connection shall be made of same material as drain pan. Dissimilar metals shall not be used to mitigate risk of galvanic corrosion. Drain connection shall be welded to the drain pan.

E. Drain pan shall be double wall with an insulation R-value of 6.25 hr-ft2-°F/ (BTU-in).

F. Drain pan shall have minimum of 2" of injected polyurethane foam insulation under the entire bottom surface of the drain pan. Drain pan shall be foam injected as a complete assembly and shall include thermal breaks at connection points to unit casing. Foam insulation shall be manufactured by EcoMate®.

G. Drain pan shall allow visual inspection and physical cleaning on 100% of the pan surface without removal of the coil or humidifier.

H. Provide a minimum of 1" clearance between the drain pan and any coil casing, coil support or any other obstruction.

I. Provide drain pan that allows the design rate of condensate drainage regardless of fan status.

J. Provide drain pan sloped in at least two planes by at least 1/8" per foot toward a single drain. Locate drain connection at the lowest point of the pan. Pan shall have no horizontal surfaces.

2.10 FANS

A. Unit shall be provided with fans as shown on equipment schedule and drawings.

B. The fan section shall be provided with an access door on the drive side of the fan.

C. Mount the fan and motor assembly on a common adjustable base. This common base shall attach to vibration isolators, which mount to structural support channels. These channels shall span the AHU floor and mount directly to the AHU frame. Manufacturers not complying with this requirement must submit detailed structural and weight data to a licensed structural engineer for review and stamped certification. The mechanical engineer shall review these engineers' final reports prior to submittal approval.

D. Provide internal vibration isolation (seismic restraining with 2" deflection).

E. DWDI fans shall be connected to the unit casing or bulkheads with canvas flexible connection.

F. Provide horizontal thrust restraints between AHU casing and fan housings with end discharge. This requirement applies to the following cases:

1. SWSI fans operating at greater than 3" of total static pressure

G. DWDI airfoil fans operating at greater than 6" of total static pressure

H. Bearings shall be offered either with sealed bearings (permanent lubrication) or with serviceable bearings to facilitate periodic relubrication. Bearings requiring relubrication shall offer grease lines extended from the bearing to an accessible location on the fan-support bracket on the drive side of the fan.

I. Piezometer Ring: Airflow station shall be factory installed at fan inlet. The device shall have a measurement accuracy of ± 5%. Tubing shall be field-installed.

2.11 BELT-DRIVE FANS

A. Belt-driven fans shall be statically and dynamically balanced by the manufacturer as a complete fan assembly including: fan wheel, motor, drive, belts and isolators.

B. Fan motor shall be provided on an adjustable base to allow adjustable and consistent belt tension. Fan and motor shall be mounted on a [formed] [welded structural] steel fan isolation base.

C. Fans shall be provided with polished steel shafts with first critical shaft speed at least 125% of the maximum operating speed for the fan pressure class. Shaft shall have an anti-corrosion coating.

D. Fan wheels shall be keyed to the fan shaft to prevent slipping.

E. Fan shall be provided with an OSHA-approved belt guard to deter incidental contact with rotating sheaves and belts.

F. Forward-Curved (FC) Fan

1. Fan shall be a double-width, double-inlet, multi-blade-type, forward-curved (FC) fan.
2. Fan shall be equipped with self-aligning, antifriction bearings.
3. Fan performance shall be certified as complying with AHRI Standard 430.

G. Airfoil (AF) Fan

1. Provide airfoil fans with blades formed of extruded aluminum, as scheduled. Bent sheet metal blades are not acceptable.
2. Airfoil fans shall comply with AMCA standard 99 2408 69 and 99 2401 82. Provide an AMCA Seal on airfoil fans. Airfoil fan performance shall be based on tests made in accordance with AMCA standards 210 and comply with the requirements of the AMCA certified ratings program for air performance.

H. Plenum (SWSI) Fan

1. Fan shall be a single-width, single-inlet, multi-blade-type, plenum fan.
2. Fan blades shall be backward-inclined airfoil.
3. Fans shall be equipped with self-aligning, anti-friction, pillow-block bearings.

2.12 DIRECT-DRIVE FANS (SINGLE OR DUAL)

A. Plenum (SWSI) Fan

1. Plenum fan wheel shall be single-width, single-inlet, with [9], [12] blades.
2. Plenum fan blades shall be aluminum backward-inclined airfoil.
3. Plenum fan shall be direct-driven.

2.13 BEARINGS AND DRIVES

B. Fan bearings shall have average life (L50) of at least 200,000 hours. Bearing fatigue life ratings shall comply with ANSI/AFBMA 9.

C. DWDI fans shall be belt-driven. SWSI fans shall be belt driven or direct driven, as shown on product drawings.

D. Re-greaseable fan bearings shall be factory lubricated and equipped with standard hydraulic grease fittings [and lube lines extended to the motor side of the fan]. Fan drives shall be selected for a 1.5 service factor and shall be furnished with anti-static belts.

1. Drives 15 hp or smaller on constant volume fans shall be adjustable pitch.
2. Drives 20 hp or larger or drives on fans with VFDs shall be fixed pitch.
3. Sheaves shall be machined from close grain cast iron and statically balanced.
4. Drive belts shall be V type, precision molded, raw edge construction, anti-static, oil and heat resistant.

2.14 ELECTRICAL MOTORS

A. Fan motors shall be built in accordance and comply with the latest standards of the NEMA and IEEE.

B. AHU and fan motors shall comply with ASHRAE 90.1.

C. Fan motors shall be provided with the following characteristics:

1. Voltage, Frequency and Phase, as scheduled.
2. Motor RPM, as scheduled
3. Minimum service factor of 1.15
4. Premium efficiency, or as required to meet ASHRAE 90.1
5. NEMA design ball bearing type
6. Rated for continuous duty at full load in a 104°F [40°C] ambient
7. Open drip proof (ODP) or totally enclosed, fan cooled (TEFC) as scheduled.
8. Suitable for use in variable frequency application, per NEMA MG-1 Part 30
9. Premium Efficiency Inverter ready per NEMA STD MG1 PART 31.4.4.2

2.17 FAN MOTOR DISCONNECTS

A. Manufacturer shall provide UL or ETL listed fan-motor disconnects and associated components, as scheduled and shown on drawings. Disconnects shall comply with applicable provisions of the National Electric Code.

B. Fused or non-fused fan-motor disconnects shall be provided in NEMA 1, NEMA 3R, NEMA 4, NEMA 12 enclosures, as scheduled or as shown on drawings.

C. Disconnects shall be mounted on the primary access side of the associated fan segment. Whereas, unit main disconnect shall be mounted [on units with single point power] on the primary access side of supply fan section.

D. Disconnect shall be suitable for use as an OSHA lockout/tagout disconnect when applied in accordance with part IV, Department of Labor OSHA 29 CFR Part 1910, Control of Hazardous Energy Source (lockout/tagout): final rule.

E. Disconnect handles shall be lockable in the "off" position with up to three padlocks. Switch mechanism shall be directly lockable in the "off" position via padlock when door is open.

F. Disconnects shall be provided with integral ground lug.

1. Provide two (2) #14 ground wires on 16A to 100A disconnects.
2. Provide one (1) #6-250 ground wire on 200A to 400A disconnects.

G. Auxiliary contacts shall be provided as scheduled.

2.18 FAN MOTOR VARIABLE FREQUENCY DRIVES (VFDS)
(SEE ALSO SECTION 232923 HEREIN FOR FURTHER REQUIREMENTS)

A. Manufacturer shall provide UL or ETL listed VFDs and associated components, as scheduled and shown on drawings. VFDs shall comply with applicable provisions of the National Electric Code.

B. VFDs shall be mounted in a dedicated NEMA 1 compartment located on the primary access side of its associated fan section and wire VFD to motor, unless otherwise indicated on drawings.

C. Outdoor VFDs shall be enclosed in a NEMA 3R enclosure.

D. VFDs on outdoor units shall be suitable for use in ambient temperatures from 5°F to 104°F:

1. Provide low ambient temperature kit suitable for use down to -20°F.
2. Provide high ambient temperature kit suitable for use up to 135°F.

E. After unit installation, VFD shall be started and programmed by a factory trained and employed service technician.

F. Unit(s) shall be provided with following VFD disconnect and bypass optional:

1. Non-Fused, Fused main disconnect
2. 2 contactor VFD bypass with VFD service input switch and Non-Fused, Fused main disconnect

G. Unit(s) shall be provided with harmonic distortion feedback protection:

1. Equivalent 5% impedance input line reactor
2. Integral RFI/EMI filtering to meet EMC EN61800-3 for First Environment

H. Unit(s) shall be provided with a user interface consisting of following features:

1. 30 Character multi-lingual alphanumeric display

2. Parameter set-up and operating data
3. Display data shall include:
    a) output frequency (Hz)
    b) speed (RPM)
    c) motor current
    d) calculated % motor torque
    e) calculated motor power (kW)
    f) DC bus voltage
    g) output voltage
    h) heat sink temperature
    i) elapsed time meter (re-settable)
    j) kWh (re-settable)
    k) input / output terminal monitor
    l) PID actual value (feedback) & error
    m) fault text
    n) warning text
    o) scalable process variable display

I. VFD shall be provided with the following protection circuits:

1. over current
2. ground fault
3. over voltage
4. under voltage
5. over temperature
6. input power loss of phase
7. loss of reference/feedback
8. adjustable current limit regulator

J. VFD shall be UL 508C approved for electronic motor overload (12t).

K. VFD shall be provided with features for high input transient protection and surge suppression, such as

1. 4 MOVs ahead of diode bridge
2. 120 Joule rated 1600V diode module
3. Compliant with UL 1449 / ANSI 61.4

L. VFD shall be provided with the following communication features:

1. Two programmable analog inputs
2. Six programmable digital inputs
3. Two programmable analog output
4. Three programmable digital relay outputs
5. Modbus RTU Communications protocol

6. Adjustable filters on analog inputs and outputs
7. Input speed signals, including 4-20 mA and 0-10 VDC
8. Accel/Decel contacts [floating point control]
9. Auto restart [customer selectable and adjustable]
10. Start/Stop options shall include 2 wire dry contact closure, application of input power, and application of reference signal (PID sleep/wake-up).
11. Integrated control interface for Siemens FLN, Johnson N2, Modbus RTU, BACnet MS/TP or LONWorks over RS-485.

M. VFD shall consist of the following functions:

1. Pre-magnetization on start
2. DC braking/hold at stop
3. Ramp or coast to stop
4. Seven preset speeds
5. Three critical frequency lockout bands
6. Start function shall include ramp, flying start, automatic torque boost, and automatic torque boost with flying start.

2.19 FACTORY INSTALLED ELECTRICAL ACCESSORIES

A. In addition to motor power terminals, unit(s) shall be provided with an independent power terminal for convenience receptacles and lights.

B. All switches shall be provided as shown on drawings.

C. Unit shall be provided with incandescent, fluorescent, LED (light emitting diode) lights in segments.

D. External light switches shall be provided with a 1-hour timer.

E. On supply fan segment 120V convenience receptacle shall be provided.

2.20 FILTERS

A. Unit[s] shall be provided with filter segments consisting of filters and frames as scheduled.

B. Side or front loading filters for filter segments located upstream of coil segment(s) shall be provided with an access door on the drive side through which filters can be easily loaded.

C. Segments located downstream of coil segment(s) shall be provided with face loading filters. Access plenum and access door of 18" [minimum] shall be provided on the drive side through which face loading filters can be easily loaded.

D. Class 2 or Class 1 filter media shall be provided per U.L. 900 and as required by local codes.

E. Filter types, efficiencies, and nominal depths shall be as follows:

1. Flat filters – 2" throwaway, 2" permanent cleanable, 2" 30% pleated, or 4" 30% pleated filters, as scheduled.
2. Angled filters – 2" throwaway, 2" permanent cleanable, or 2" 30% pleated filters, as scheduled.
3. Rigid filters – 12" rigid filters with efficiency of 90-95% , MERV 14, respectively; as scheduled.

F. A pre-filter rack shall be provided in rigid filter segments. Pre-filters shall have 2" throwaway, 2" permanent cleanable, 2" 30% pleated, or 4" 30% pleated filters as scheduled.

G. Performance of installed filtration system shall be certified via a DOP test and classified as UL Class 1 when tested in accordance with UL Standard 586.

H. Flush mounted, factory installed differential pressure gage on the drive side of unit shall be provided to measure pressure drop across filters. Manufacturer shall provide fully functional gauges, complete with tubing.

2.21 DAMPERS

A. Dampers provided shall be tested in accordance with AMCA 500.

B. Factory-installed dampers shall be provided, as shown on drawings.

C. Dampers shall have airfoil blades, extruded vinyl edge seals, and flexible metal compressible jamb seals.

D. Dampers shall have a maximum leakage rate of 4 CFM/square foot at 1" w.g., and shall comply with ASHRAE 90.1.

E. Damper blades shall be parallel acting unless otherwise indicated.

2.22 AIRFLOW MONITORING STATIONS

A. Airflow monitoring stations shall be provided on air inlets, as shown in performance specifications.

B. Airflow monitoring stations shall bear the AMCA Certified Ratings Seal for Airflow Measurement Performance.

C. Airflow monitoring station dampers shall comply with leakage rates per ASHRAE 90.1.

D. Airflow monitoring stations shall be accurate within 5% of actual airflow between 300 FPM and 3000 FPM free area velocity.

E. Factory installed transducer that sends a CFM-proportional, 4-20 mA or 0-10V signal shall be provided only when factory packaged controls option is selected.

2.23 DIFFUSERS

A. Diffuser segments shall be provided, as shown on product drawings.

B. Perforated steel diffuser plates shall be installed between fans and downstream components when required to ensure proper velocity profiles across downstream components.

2.24 APPURTENANCES

A. Rain hoods shall be provided on outdoor unit air intakes. Moisture screens shall be provided on outdoor air inlet rain hoods.

B. Steel, structural formed or welded, base rails suitable for rigging and lifting shall be provided, as shown on product drawings.

C. Safety grates over bottom openings shall be provided. Safety grates shall be capable of supporting a 300 lb. center load.

D. Lifting lugs shall be provided where required.

2.25 EXTERIOR FINISHES

A. Manufacturer shall clean the exterior surfaces of units prior to application of exterior protective coating.

B. Manufacturer shall paint exterior surfaces of outdoor units prior to shipment.

1. Manufacturer shall apply a primer prior to application of finish coating.
2. Exterior finish coating shall show a breakdown of less than 1/8” on either side of a scribed line when subjected to ASTM B117 3,500 hour, 5% salt spray conditions. This is equivalent to an ASTM D1654 rating of ‘6.’ Also, per ASTM D610, degree of rusting to meet #8-G and per ASTM D714 degree of blister to meet #6 medium.

2.26 LIGHTS AND OUTLETS

A. Lights
1. Factory shall provide vapor resistant, marine type LED lighting fixture located in segments and quantity as indicated on the drawings.
2. Factory shall wire all light fixtures to a common 120v switch located on the supply fan segment.
3. Factory shall wire each light fixture to a separate 120v switch located near the access door of the segment with the light fixture.

B. Outlets

1. Factory shall provide a 15A GFI duplex outlet mounted in a weatherproof enclosure in segments and quantity as indicated on the drawings.

2.27 ACCESS PLENUMS

A. Provide access plenum sections with hinged door no smaller than 18" X 36" as indicated on the drawings. Construction of the plenum shall be similar to the unit casing.

B. Provide spacer or access section between heating and cooling coils, minimum separation of coils is 10” to allow installation of temperature sensors.

2.28 ROOF MOUNTING CURBS

A. Construct roof mounting curb to mate and seal with the unit casing base. Provide positive connection between curb and unit base and curb and building structure. Curb shall be of sufficient height, minimum 24”, to provide a minimum height of eight (8) inches above finished roof.

B. Provide seismic rated curb per seismic certification detailing.

C. Construct the curb of galvanized steel to support the perimeter of the entire unit. Form the cross section of the curb members to accept insulation. Form the top curb members to accept “tie down” attachments of associated equipment.

D. Gasketing shall be provided for field mounting between the unit base and the roof curb.

E. The curb is to be furnished by this Contractor and then turned over to the General Contractor for installation.

F. The roof curb shall be insulated with 2” thick 3 PCF insulation and provided with drywall sheets for controlling break-out noise.

G. The roof curb shall be sloped to accommodate installation on a sloped surface.

H. Attachment of rooftop unit to curb per Structural drawings and seismic certification detailing.

2.29 ELECTRICAL

A. Air handling unit shall be supplied with motor and heater controllers, means of disconnect and overcurrent protection in accordance with mechanical, control and electrical specifications.

1. Furnish each variable speed three phase motor with factory mounted variable frequency drive, VFD, with bypass, circuit breaker or fused disconnect switch,

transformers and all necessary motor starter, contactor and overcurrent protection. The VFD shall be mounted within the unit casing in a dedicated conditioned control compartment.

2. Furnish each constant speed three phase motor with factory mounted weatherproof factory mounted starter, circuit breaker or fused disconnect switch, transformers and all necessary motor starter, contactor and overcurrent protection.
3. Units with supply fans and exhaust (return) fans shall have a separate VFD with bypass or motor starter for each fan.
4. Furnish each single phase motor with motor controller and internal thermal overload protection or separate overload device.

2.31 SOURCE QUALITY CONTROL

A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.

B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Compliance: In accordance with approved submittals and manufacturer’s written installation instructions.

B. Equipment Mounting: Install air-handling units on roof mounted curbs. Install roof mounting curb as an integral member of the building roof structure. Rough in for power, control, piping and tie downs to be completed prior to setting unit on curb.

C. Comply with mounting and anchoring requirements for seismic and wind installations.

D. Secure unit and curb mounting assembly to structure with positive attachments in accordance with Structural and seismic certification detailing. Provide clips to secure AHU to curb as detailed.

E. Mount unit to provide proper slope in condensate drain pan towards drain line.

F. Install work readily accessible for normal operation, reading of instruments (in vertical position), adjustment, service, inspection and repair. Provide access panels where indicated and required. Access panels shall be the responsibility of the respective subcontractor.

G. Install units to provide access space around air-handling units for service and maintenance.

H. Do not operate fan system until specified filters are in place. Replace dirty filters if used during construction prior to owner occupancy.

I. Install filter-gage or verify factory installation, with static-pressure taps upstream and downstream of each filters section. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages for each filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Mount unit at sufficient height above roof so that proper trap is provided in the condensate drain line.

C. Install piping adjacent to air-handling unit to allow service and maintenance.

D. Provide internal wiring conduits so that all electrical and control wiring penetrates building roof within interior of roof curb to eliminate exposed wiring and conduit.

E. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

F. Connect condensate drain pans using ASTM B 88, Type M copper tubing. Refer to Drawings for drain sizes or route full size to equipment or floor drain. Extend to nearest roof drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

G. Refrigerant Piping: Comply with drawing requirements. Include union at each supply and return connection.

H. Connect duct to air-handling units with flexible connections. Comply with requirements in Division 23 Section "Air Duct Accessories."

I. Install piping adjacent to coils to allow service and maintenance and provide proper coil pull from the air handling equipment without the removal of main piping or excessive amounts of branch piping.

3.4 FIELD QUALITY CONTROL

A. Perform test, inspections and prepare test reports including:

1. Complete startup checklists according to manufacturer's written instructions.
2. Piping Vestibules: Verify waterproof installation for exterior type vestibules to prevent rain from entering the vestibule, air handling unit cabinet and building. Verify piping vestibule is sealed air tight to the air handling unit air stream including piping and conduit penetrations.
3. Verify that shipping, blocking, and bracing are removed.
4. Verify that unit is secure on curbs or supporting devices and that connections to piping, ducts, and electrical systems are complete.
5. Verify that proper thermal-overload protection is installed in motors, controllers, electric heaters and switches.
6. Verify proper motor rotation direction, free fan wheel rotation, energy wheel rotation, belt alignment, belt tension and smooth bearing operations.
7. Verify that bearings and other moving parts are lubricated with factory-recommended lubricants.
8. Verify that zone dampers fully open and close for each zone.
9. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
10. Comb coil fins for parallel orientation.
11. Verify that proper thermal-overload protection is installed for electric coils.
12. Install new, clean filters.
13. Verify that manual and automatic volume, control, and fire and smoke dampers in connected duct systems are in fully open position.

B. Inspect components, assemblies, and equipment installations, including connections and controls. Starting procedures for air-handling units include the following:

1. Verify installation is in accord with manufacturer’s written instructions.
2. Verify startup checklist.
3. Verify ERV control damper operation, wheel speed settings, heating coil set points and other auxiliaries function according to manufacturer’s instructions and control sequence.
4. Verify installation of AHU controllers, controlled devices control wiring and power wiring and proper functioning of all operational and safety controls and unit performance.
5. Energize motor; verify proper operation of motor, drive system, and fan wheel.

6. Measure and record motor electrical values for voltage and amperage and compare to nameplate and motor overloads.

C. Air-handling unit or components will be considered defective if unit or components do not pass test and inspections. Make necessary corrections and repeat test and inspections.

D. Prepare and submit inspection, test and startup reports.

3.5 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.6 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION

SECTION 23 81 29 – VARIABLE-REFRIGERANT-FLOW HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes complete VRF HVAC system(s) including, but not limited to the following components to make a complete operating system(s) according to requirements indicated:

1. Indoor units.
2. Outdoor units.
3. System controls.

1.3 DEFINITIONS

A. Air-Conditioning System Operation: System capable of operation with all zones in cooling only.

B. Heat-Pump System Operation: System capable of operation with all zones in either heating or cooling, but not with simultaneous heating and cooling zones that transfer heat between zones.

C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

D. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.

E. Two-Pipe System Design: One refrigerant vapor line and one refrigerant liquid line connect a single outdoor unit or multiple manifold outdoor units in a single system to associated system HRCUs. One refrigerant liquid line and refrigerant vapor line connect HRCUs to associated indoor units. HRCUs used in two pipe systems act as an intermediate heat exchanger and include diverting valves and gas/liquid separators to move high and low pressure refrigerant between indoor units.

F. VRF: Variable refrigerant flow.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: VRF Systems, components and mounting assemblies shall withstand the effects of seismic forces in accord with project Seismic specifications.

B. Service Access:

1. Provide and document service access requirements.
2. Locate equipment, system isolation valves, and other system components that require service and inspection in easily accessible locations. Avoid locations that are difficult to access if possible.
3. Where serviceable components are installed behind walls and above inaccessible ceilings, provide finished assembly with access doors or panels to gain access. Properly size the openings to allow for service, removal, and replacement.
4. If less than full and unrestricted access is provided, locate components within an 18-inch reach of the finished assembly.
5. Where ladder access is required to service elevated components, provide an installation that provides for sufficient access within ladder manufacturer's written instructions for use.
6. Comply with OSHA regulations.

C. System Design and Installation Requirements:

1. Design and install systems indicated according to manufacturer's recommendations and written instructions.
2. Where manufacturer's requirements differ from requirements indicated, contact Architect for direction. The most stringent requirements should apply unless otherwise directed in writing by Architect.

D. System Adaptability to Future Changes: Arrange and size system refrigerant piping to accommodate future changes to system without having to resize and replace existing refrigerant piping.

1. Each branch circuit shall accommodate addition of one indoor unit(s) with unit capacity equal to average indoor unit connected to the branch circuit.
2. Each branch circuit shall accommodate deletion of one indoor unit(s) with unit capacity equal to average indoor unit connected to the branch circuit

E. Isolation of Equipment: Provide isolation valves to isolate each HRCU, indoor unit and outdoor unit for service, removal, and replacement without interrupting system operation.

F. System Turndown: Stable operation down to 15 percent of outdoor-unit capacity.

G. System Auto Refrigerant Charge: Each system shall have an automatic refrigerant charge function to ensure the proper amount of refrigerant is installed in system.

H. Sound Performance: Sound levels generated by operating HVAC equipment shall be within requirements indicated.

1. Indoor: Within design guidelines of "ASHRAE HANDBOOK- HVAC Applications."
2. Outdoor: Within ordinance of governing authorities.

I. Thermal Movements: Allow for controlled thermal movements from ambient, surface, and system temperature changes

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

A. Submittals shall be prepared by MFR's representative that participated in the construction documents preparation. Refer to Part 2 Manufacturer's for contact information.

B. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for indoor and outdoor units and for HRCUs, if applicable.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Include operating performance at design conditions and at extreme maximum and minimum outdoor ambient conditions.
4. Include description of system controllers, dimensions, features, control interfaces and connections, power requirements, and connections.
5. Include system operating sequence of operation in narrative form for each unique indoor- and outdoor-unit and HRCU control, if applicable.
6. Include description of control software features.
7. Include total refrigerant required and a comprehensive breakdown of refrigerant required by each system installed.
8. Include refrigerant type and data sheets showing compliance with requirements indicated.
9. For system design software.
10. Indicate location and type of service access.

C. Shop Drawings: For VRF HVAC systems.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
4. Include diagrams and details of refrigerant piping and tubing showing installation requirements for manufacturer-furnished divided flow fittings.

5. Include diagrams of all piping systems and grouping of indoor units and outdoor condensing unit modules.
6. Include diagrams for power, signal, and control wiring.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Installer: Certificate from VRF HVAC system manufacturer certifying that Installer has successfully completed prerequisite training administered by manufacturer for proper installation of systems, including but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.

a. Retain copies of Installer certificates on-site and make available on request.

2. For VRF HVAC system manufacturer.
3. For VRF HVAC system provider.

B. ASHRAE-15 Compliance: Provide complete refrigerant calculations that show compliance with ASHRAE-15 for equipment or piping located in the smallest room.

C. Seismic Qualification: Manufacturer's certification of seismic qualification according to ASCE 7. Submit ASCE 7 special seismic certification as required. Include method used to determine compliance with requirements.

1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VRF HVAC systems to include in emergency, operation, and maintenance manuals. Include startup service reports and special warranty.

1.9 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters:

a. One set(s) for each unit type and unique size of washable filters.

1.10 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of VRF systems and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning

E. Manufacturer Qualifications:

1. Nationally recognized manufacturer of VRF HVAC systems and products.
2. Shipped VRF HVAC systems with similar requirements to those indicated for a continuous period of 10 years within time of bid.
3. VRF HVAC systems and products that have been successfully tested and in use on at least five completed projects.
4. Having complete published catalog literature, installation, and operation and maintenance manuals for all products intended for use.
5. Having full-time in-house employees for the following:

a. Product research and development.
b. Product and application engineering.
c. Product manufacturing, testing, and quality control.
d. Technical support for system installation training, startup, commissioning, and troubleshooting of installations.
e. Owner training.

F. Factory-Authorized Service Representative Qualifications:

1. Authorized representative of, and trained by, VRF HVAC system manufacturer.
2. In-place facility located within 50 miles of Project.
3. Demonstrated past experience with products being installed for period within five consecutive years before time of bid.
4. Demonstrated past experience on five projects of similar complexity, scope, and value.

a. Each person assigned to Project shall have demonstrated past experience.

5. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
6. Service and maintenance staff assigned to support Project during warranty period.

7. Product parts inventory to support ongoing system operation for a period of not less than five years after Substantial Completion.
8. VRF HVAC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.

G. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by VRF HVAC system manufacturer.

1. Each employee shall be certified by manufacturer for proper installation of systems, including, but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.
2. Installer certification shall be valid and current for duration of Project.
3. Retain copies of Installer certificates on-site and make available on request.
4. Each person assigned to Project shall have demonstrated past experience.

a. Demonstrated past experience with products being installed for period within five consecutive years before time of bid.
b. Demonstrated past experience on five projects of similar complexity, scope, and value.

5. Installers shall have staffing resources of competent, trained, and experienced full-time employees that are assigned to execute work according to schedule.

H. ISO Compliance: System equipment and components furnished by VRF HVAC system manufacturer shall be manufactured in an ISO 9001 and ISO 14001 facility.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in a clean and dry place.

B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.

D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.

1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.
2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remover coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.

E. Replace installed products damaged during construction.

1.12 DESIGN CRITERIA

A. The air conditioning equipment Condensing Unit shall be specifically designed for mounting in an outdoor application: curb or pedestal mounting as indicated on the drawings. The VRF equipment and attachments to structure shall be designed to conform with the wind and seismic structural loading requirements identified in "Performance Requirement".

B. All electrical components to be UL Listed.

C. Total unit to be UL listed.

D. All materials to meet requirements of NFPA 90A.

E. Units shall have the configuration as indicated on the plans and/or as scheduled.

F. Indoor units shall meet or exceed the scheduled cooling and heating capacity, selected and rated in accordance with ARI 410.

G. Units shall not be selected at high fan speed unless noted otherwise.

H. Indoor units shall be provided with all necessary tags and decals to aid in the service and/or indicate caution areas. Electrical wiring diagrams shall be attached to the control panel access door. Lifting lugs shall be supplied to facilitate rigging of the air-handling unit.

I. Outdoor and indoor units shall be of same manufacturer. Units shall be factory run tested to check cooling and heating operation, defrost initiation and termination, fan and blower rotation and control sequence. Units shall be designed to operate at ambient temperatures between 120 degrees F and 30 degrees F on cooling mode and 70 degrees F and 0 degrees F on heating mode. Cooling and heating capabilities shall be rated in accordance with ARI standards

1.13 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace equipment and components that fail(s) in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor: Five year(s) from date of Substantial Completion.
b. For Parts, Including Controls: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Design is based on Mitsubishi/Trane. Subject to compliance with requirements, the following manufacturer is also acceptable provided system components have HCAI seismic certification. Substitutions will not be accepted:

1. Daikin

B. Source Limitations: Obtain products from single source from single manufacturer including, but not limited to, the following:

1. Indoor and outdoor units, including accessories.
2. Controls and software.
3. Refrigerant isolation valves.
4. Specialty refrigerant pipe fittings.

2.2 SYSTEM DESCRIPTION

A. Direct-expansion (DX) VRF HVAC system(s) with variable capacity in response to varying cooling and heating loads. System shall consist of multiple indoor units, outdoor unit(s), piping, controls, and electrical power to make complete operating system(s) complying with requirements indicated.

1. Two-pipe system design.
2. System(s) operation, air-conditioning, heat pump as indicated on Drawings.
3. Each system with one refrigerant circuit shared by all indoor units connected to system.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. AHRI Compliance: System and equipment performance certified according to AHRI 1230 and products listed in AHRI directory.

D. ASHRAE Compliance:

1. ASHRAE 15: For safety code for mechanical refrigeration.
2. ASHRAE 62.1: For indoor air quality.
3. ASHRAE 135: For control network protocol with remote communication.
4. ASHRAE/IES 90.1 Compliance: For system and component energy efficiency.

E. UL Compliance: Comply with UL 1995.

2.3 INDOOR UNITS

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.

B. Cabinet:

1. Concealed unit cabinet material: Galvanized painted steel.
2. Exposed cabinet material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
3. Exposed wall mounted unit cabinet material
4. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.
5. For ducted units: Extended collar or flange, or designated exterior cabinet surface, designed for attaching field-installed ductwork.
6. Mounting: Manufacturer-designed provisions for field installation.
7. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. DX Coil Assembly:

1. Coil Casing: Aluminum, galvanized, or stainless steel.
2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
3. Coil Tubes: Copper, of diameter and thickness required by performance.
4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
5. Unit Internal Tubing: Copper tubing with brazed joints.
6. Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
7. Field Piping Connections: Manufacturer's standard.
8. Factory Charge: Dehydrated air or nitrogen.
9. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:

1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
2. Condensate Removal:

a. Ceiling or Wall Mounted units: Unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.
b. Floor Mounted Units: Provide unit with field installed condensate pump accessory if unit cannot be gravity drain to floor drain at the units.

3. Field Piping Connection: Non-ferrous material.

E. Fan and Motor Assembly:

1. Fan(s):

a. Direct-drive arrangement.
b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
c. Fabricated from non-ferrous components or ferrous components with corrosion-resistant finish.
d. Wheels statically and dynamically balanced.

2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
5. Vibration Control: Integral isolation to dampen vibration transmission.

F. Filter Assembly:

1. Access: Bottom, side, or rear to accommodate field installation without removing ductwork and to accommodate filter replacement without need for tools.
2. Efficiency: ASHRAE 52.2, MERV 7.
3. Media: Manufacturer’s standard replaceable or washable filter.

G. Grille Assembly (For Non-Ducted Units):

1. Floor or Wall Mounted Unit: Manufacturer's standard discharge grille with field-adjustable air pattern mounted in top of unit cabinet.
2. Ceiling Mounted Unit: Mounted in bottom of unit cabinet.

a. Supply Grille Assembly:

1) Discharge Pattern: One-, two-, three-, or four-way throw as indicated on Drawings.
2) Discharge Pattern Adjustment: Field-adjustable limits for up and down range of motion.
3) Discharge Pattern Closure: Ability to close individual discharges of units with multiple patterns.
4) Retain "Motorized Vanes" or "Additional Branch Supply Duct Connection" Subparagraph below, or both, to provide grille assembly with additional features. Features indicated may not be available from all manufacturers on all products. Consult manufacturers for availability.
5) Motorized Vanes: Modulating up and down flow pattern for uniform room air distribution.

6) Additional Branch Supply Duct Connection: Sheet metal knockout for optional connection to one additional supply branch duct.

b. Return-Air Grille Assembly: Manufacturer's standard grille mounted in bottom of unit cabinet

H. Unit Accessories:

1. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.
2. Condensate Pump: Integral reservoir and control with electrical power connection at unit.

I. Unit Controls:

1. This unit shall use controls provided by the VFR System manufacturer to perform functions necessary to operate the system.
2. The units shall have a factory built in receiver for wireless remote control.
3. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
4. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
5. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

J. Unit Electrical:

1. Enclosure: Metal, suitable for indoor locations.
2. Field Connection: Single point connection to power unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in metal raceways.

2.4 OUTDOOR UNITS, AIR-SOURCE HEAT-PUMP

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

1. Specially designed for use in systems with either all heating or all cooling demands, or for use in systems with simultaneous heating and cooling, as indicated on the drawings.

2. Systems shall consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.
3. All units installed shall be from the same product development generation.

B. Cabinet:

1. Galvanized steel and coated with a corrosion-resistant finish.

   a. Coating with documented salt spray test performance of 1000 hours according ASTM B117 surface scratch test (SST) procedure.

2. Mounting: Manufacturer-designed provisions for field installation.
3. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. Compressor and Motor Assembly:

1. One or more positive-displacement, direct-drive and hermetically sealed scroll compressor(s) with inverter drive and turndown to 15 percent of rated capacity.
2. Protection: Integral protection against the following:

   a. High refrigerant pressure.
   b. Low oil level.
   c. High oil temperature.
   d. Thermal and overload.
   e. Voltage fluctuations.
   f. Phase failure and phase reversal.
   g. Short cycling.

3. Speed Control: Variable to automatically maintain refrigerant suction and condensing pressures while varying refrigerant flow to satisfy system cooling and heating loads.
4. Vibration Control: Integral isolation to dampen vibration transmission.
5. Oil management system to ensure safe and proper lubrication over entire operating range.
6. Crankcase heaters with integral control to maintain safe operating temperature.
7. Fusible plug.

D. Condenser Coil Assembly:

1. Plate Fin Coils:

   a. Casing: Aluminum, galvanized, or stainless steel.
   b. Fins: Aluminum or copper, mechanically bonded to tubes, with arrangement required by performance.
   c. Tubes: Copper, of diameter and thickness required by performance.

2. Aluminum Microchannel Coils:

   a. Series of flat tubes containing a series of multiple, parallel-flow microchannels layered between refrigerant header manifolds.
   b. Single- or multiple-pass arrangement.
   c. Construct fins, tubes, and header manifolds of aluminum alloy.

3. Coating: None

E. Condenser Fan and Motor Assembly:

1. Fan(s): Propeller type.

   a. Direct-drive arrangement.
   b. Fabricated from non-ferrous components or ferrous components with corrosion protection finish to match performance indicated for condenser coil.
   c. Statically and dynamically balanced.

2. Fan Guards: Removable safety guards complying with OSHA regulations. If using metal materials, coat with corrosion-resistant coating to match performance indicated for condenser coil.
3. Motor(s): Brushless dc or electronically commutated with permanently lubricated bearings and rated for outdoor duty.
4. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
5. Speed Settings and Control: Variable speed with a speed range of least 75 percent.
6. Vibration Control: Integral isolation to dampen vibration transmission.

F. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.

G. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for unprotected outdoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Factory-Installed Sensors:

   a. Refrigerant suction temperature.
   b. Refrigerant discharge temperature.
   c. Outdoor air temperature.
   d. Refrigerant high pressure.
   e. Refrigerant low pressure.
   f. Oil level.

4. Features and Functions: Self-diagnostics, time delay, auto-restart, fuse protection, auto operation mode, manual operation mode, night setback

control, power consumption display, run test switch equalize run time between multiple same components.
5. Communication: Network communication with indoor units and other outdoor unit(s).
6. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
7. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

H. Unit Electrical:

1. Enclosure: Metal, similar to enclosure, and suitable for unprotected outdoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in metal raceways to comply with NFPA 70.

I. Unit Hardware: Zinc-plated steel, or stainless steel. Coat exposed surfaces with additional corrosion-resistant coating if required to prevention corrosion when exposed to salt spray test for 1000 hours according ASTM B117.

J. Unit Piping:

1. Unit Tubing: Copper tubing with brazed joints.
2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
3. Field Piping Connections: Manufacturer's standard.
4. Factory Charge: Dehydrated air or nitrogen.
5. Testing: Factory pressure tested and verified to be without leaks.

2.5 INDOOR, HYDRONIC HEAT-PUMP

A. Description: Factory -assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

1. Specially designed for use in systems with either all heating or all cooling demands, or for use in systems with simultaneous heating and cooling, as indicated on the drawings
2. Systems shall consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.
3. All units installed shall be from the same product development generation.

B. Cabinet:

1. Galvanized-steel construction.
2. Mounting: Manufacturer-designed provisions for field installation.
3. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.
4. Internal Cabinet Cooling: Unit shall include integral cabinet cooling to maintain inside of cabinet within acceptable operating temperature for internal components.

    a. If unit is not available with integral cooling, provide a field-installed indoor unit that is dedicated to provide cabinet cooling.

C. Compressor and Motor Assembly:

1. One or more positive-displacement, direct-drive and hermetically sealed scroll compressor(s) with inverter drive and turndown to 15 percent of rated capacity.
2. Protection: Integral protection against the following:

    a. High and low refrigerant pressure.
    b. Low oil level.
    c. High oil temperature.
    d. Thermal and overload.
    e. Voltage fluctuations.
    f. Phase failure and phase reversal.
    g. Short cycling.

3. Speed Control: Variable to automatically maintain refrigerant suction and condensing pressures while varying refrigerant flow to satisfy system cooling and heating loads.
4. Vibration Control: Integral isolation to dampen vibration transmission.
5. Oil management system to ensure safe and proper lubrication over entire operating range.
6. Crankcase heaters with integral control to maintain safe operating temperature.
7. Fusible plug.

D. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.

E. Heat-Exchanger Assembly:

1. Brazed plate heat exchanger(s) with performance indicated on Drawings.
2. Testing: Factory pressure tested and verified to be without leaks.
3. Drain: Hydronic side of assembly with drain connection at low point.

F. Unit Accessories:

1. Strainer: Y-pattern strainer for installation on entering hydronic piping to unit.

G. Unit Controls:

1. This unit shall use controls provided by the VFR System manufacturer to perform functions necessary to operate the system.
2. Unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
3. Unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

H. Unit Electrical:

1. Enclosure: Metal, similar to enclosure, and suitable for unprotected outdoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in metal raceways to comply with NFPA 70.

I. Unit Hardware: Zinc-plated steel, or stainless steel.

J. Unit Piping:

1. Unit Tubing: Copper tubing with brazed joints.
2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
3. Field Piping Connections: Manufacturer's standard.
4. Factory Charge: Dehydrated air or nitrogen.
5. Testing: Factory pressure tested and verified to be without leaks.

2.6 SYSTEM CONTROLS

A. General Requirements:

1. Network: Indoor units, HRCUs, and outdoor units shall include integral controls and connect through a TIA-485A or manufacturer-selected control network.
2. Network Communication Protocol: Open control communication between interconnected units.
3. Integration with Building Automation System: ASHRAE 135, BACnet IP and certified by BACnet Testing Lab (BTL), including the following:

a. Ethernet connection via RJ-45 connectors and port with transmission at 100 Mbps or higher.

b. Integration devices shall be connected to local uninterruptible power supply unit(s) to provide at least 5 minutes of battery backup operation after a power loss.
c. Integration shall include control, monitoring and scheduling.

4. Operator Interface:

a. Operators shall interface with system and unit controls through the following:

1) Operator interfaces integral to controllers.
2) Integration with Building Automation System.

b. Users shall be capable of interface with controllers for indoor units control to extent privileges are enabled. Control features available to users shall include the following:

1) On/off control.
2) Temperature set-point adjustment.

B. VRF HVAC System Operator Software for PC:

1. Software offered by VRF HVAC system manufacturer shall provide system operators with ability to monitor and control VRF HVAC system(s) from a single dedicated Owner-furnished PC.
2. Software shall provide operator with a graphic user interface to allow monitoring and control of multiple central controllers from a single device location through point-and-click mouse exchange.
3. Plan views shall show building plans with location of indoor units and identification superimposed on plans.
4. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.
5. Schedules operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Schedules daily, weekly, and annual events.
6. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
7. Optimized start feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.
8. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.
9. Supports Multiple Languages.
10. Supports Imperial and Metric Temperature Units: Fahrenheit and Celsius.
11. Monitors and displays cumulative operating time of indoor units.
12. Able to disable and enable operation of individual controllers for indoor units.
13. Information displayed on individual controllers shall also be available for display.
14. Information displayed for outdoor units, including refrigerant high and low pressures percent capacity.

C. Central Controllers:

1. Centralized control for all indoor and outdoor units from a single central controller location.

   a. Include multiple interconnected controllers as required.

2. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.
3. Schedule operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.

   a. Sets schedule for daily, weekly, and annual events.
   b. Schedule options available through central controller shall at least include the schedule options of controllers for indoor units.

4. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
5. Optimized start feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.
6. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.
7. Service diagnostics tool.
8. Able to disable and enable operation of individual controllers for indoor units.
9. Information displayed on individual controllers shall also be available for display through central controller.
10. Information displayed for outdoor units, including refrigerant high and low pressures percent capacity.
11. Multiple RJ-45 ports for direct connection to a local PC and an Ethernet network switch.
12. Operator interface through a backlit, high-resolution color display touch panel and web accessible through standard web browser software.

D. Wired Controllers for Indoor Units:

1. Single controller capable of controlling multiple indoor units as group.
2. Auto Timeout Touch Screen LCD: Timeout duration shall be adjustable.
3. Multiple Language.
4. Temperature Units: Fahrenheit and Celsius.
5. On/Off: Turns indoor unit on or off.
6. Hold: Hold operation settings until hold is released.
7. Operation Mode: Cool, Heat, Auto, Dehumidification, Fan Only, and Setback.
8. Temperature Display: 1-degree increments.
9. Temperature Set-Point: Separate set points for Cooling, Heating, and Setback. Adjustable in 1-degree increments.
10. Relative Humidity Display: 1 percent increments.
11. Relative Humidity Set-Point: Adjustable in 1 percent increments.

12. Fan Speed Setting: Select between available options furnished with the unit.
13. Airflow Direction Setting: If applicable to unit, select between available options furnished with the unit.
14. Seven-day programmable operating schedule with minimum five events per day. Operations shall include On/Off, Operation Mode, and Temperature Set-Point.
15. Auto Off Timer: Operates unit for an adjustable time duration and then turns unit off.
16. Occupancy detection.
17. Service Notification Display.
18. Service Run Tests: Limit use by service personnel to troubleshoot operation.
19. Error Code Notification Display: Used by service personnel to troubleshoot abnormal operation and equipment failure.
20. User and Service Passwords: Capable of preventing adjustments by unauthorized users.
21. Setting stored in nonvolatile memory to ensure that settings are not lost if power is lost. Battery backup for date and time only.
22. Low-voltage power required for controller shall be powered through non-polar connections to indoor unit.

E. BAS Integration and Communication:

1. VRF system controls shall communicate and be integrated with the BAS system. VRF controls shall have capability for the BAS system to:

   a. Schedule and adjust setpoint of indoor units, either individually or as groups of units.
   b. Obtain operating status of all indoor and outdoor units
   c. Display service notifications and error codes from the system.
   d. Record error history of system.
   e. Monitor and display operating time of indoor units.
   f. Enable and Disable operation of individual controllers for indoor units.
   g. Reset the system thermostat temperature setpoints upon loss of power should the system thermostats default to last commanded setpoint.

2.7 SYSTEM REFRIGERANT AND OIL

A. Refrigerant:

1. As required by VRF HVAC system manufacturer for system to comply with performance requirements indicated.
2. ASHRAE 34, Class A1 refrigerant classification.
3. R-410a.

2.8 SYSTEM REFRIGERANT PIPING

A. Comply with requirements in Division 23 Section "Refrigerant Piping" for system piping requirements and VRF manufacturer's installation instructions. Provide all required components and specialty fittings by VRF system manufacturer.

2.9 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect factory-assembled equipment.

B. Equipment will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports for historical record. Submit reports only if requested.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine products before installation. Reject products that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for piping and tubing to verify actual locations of connections before equipment installation.

D. For units with ductwork, examine roughing-in for ductwork to verify actual locations of connections before equipment installation.

E. Examine roughing-in for wiring and conduit to verify actual locations of connections before equipment installation.

F. Examine walls, floors, roofs, and outdoor pads for suitable conditions where equipment will be installed.

G. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

H. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION, GENERAL

A. Clearance:

1. Maintain manufacturer's recommended clearances for service and maintenance.
2. Maintain clearances required by governing code.

B. Loose Components: Install components, devices, and accessories furnished by manufacturer, with equipment, that are not factory mounted.

1. Loose components shall be installed by manufacturer's service representative.

C. Comply with mounting and anchoring requirements for seismic installations

3.3 INSTALLATION OF INDOOR UNITS

A. Install units to be level and plumb while providing a neat and finished appearance.

B. Unless otherwise required by VRF HVAC system manufacturer, support ceiling-mounted units from structure per Structural drawing detail.

C. Adjust supports of exposed and recessed units to draw units tight to adjoining surfaces.

D. Protect finished surfaces of ceilings, floors, and walls that come in direct contact with units. Refinish or replaced damaged areas after units are installed.

E. In rooms with ceilings, conceal piping and tubing, controls, and electrical power serving units above ceilings.

F. In rooms without ceiling, arrange piping and tubing, controls, and electrical power serving units to provide a neat and finished appearance.

G. For wall-mounted units that are exposed, conceal piping and tubing, controls, and electrical power serving units within walls.

H. Attachment: Install hardware for proper attachment to supported equipment.

3.4 INSTALLATION OF OUTDOOR UNITS

A. Install units to be level and plumb while providing a neat and finished appearance.

B. Install outdoor units on support structures indicated on Drawings.

C. Roof-Mounted Installations: Install outdoor units on equipment supports per Structural drawings.

3.5 GENERAL REQUIREMENTS FOR PIPING INSTALLATION

A. Refer to Division 23 Section “Refrigerant Piping” for installation requirements for refrigerant piping.

B. Install refrigerant piping per VRF system manufacturer's installation requirements.

C. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping and tubing systems. Install piping and tubing as indicated unless deviations to layout are approved on coordination drawings.

3.6 ELECTRICAL INSTALLATION

A. Comply with requirements indicated on Drawings and in applicable Division 26 Sections.

B. To extent electrical power is required for system equipment, components, and controls, and is not indicated on Drawings and addressed in the Specifications, the design for such electrical power shall be delegated to VRF HVAC system provider.

1. Delegated design of electrical power to equipment, components and controls, and associated installation shall be included at no additional cost to Owner.

C. Connect field electrical power source to each separate electrical device requiring field electrical power. Coordinate termination point and connection type with Installer.

3.7 INSTALLATION OF SYSTEM CONTROL CABLE

A. Comply with manufacturer's installation requirements.

3.8 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage VRF HVAC system manufacturer's service representative to advise and assist installers; witness testing; and observe and inspect components, assemblies, and equipment installations, including controls and connections.

1. Field service shall be performed by a factory-trained and -authorized service representative of VRF HVAC system manufacturer whose primary job responsibilities are to provide direct technical support of its products.
2. Manufacturer shall provide on-site visits during the course of construction at installation milestones indicated. System Installer shall coordinate each visit in advance to give manufacturer sufficient notice to plan the visit.

a. First Visit: Kick-off meeting.
b. Second Visit: At approximately 25 percent completion of system(s).
c. Third Visit: At approximately 50 percent completion of system(s).
d. Fourth Visit: At approximately 75 percent completion of system(s).
e. Fifth Visit: Final inspection before system startup.

3. Kick-off Meeting:

a. Meeting shall include system Installer and other related trades with sole purpose of reviewing VRF HVAC system installation requirements and close coordination required to make a successful installation.
b. Meeting shall be held at Project site and scheduled at a mutually agreed to time that occurs before the start of any part of system installation.
c. Meeting shall cover the following as a minimum requirement:

1) Review of latest issue of Contract Documents, Drawings, and Specifications, relevant to VRF HVAC systems.
2) Manufacturer's installation requirements specific to systems being installed.
3) Review of all relevant VRF HVAC system submittals, including delegated-design submittals.
4) Required field activities related installation of VRF HVAC system.
5) Project team communication protocol, contact information, and exchange of responsibilities for each party involved, including manufacturer, supplier, system Installer, and other related trades.

4. Site Visits: Activities for each site visit shall include the following:

a. Meet with VRF HVAC system Installer to discuss field activities, issues, and suggested methods to result in a successful installation.
b. Offer technical support to Installer and related trades as related to VRF system(s) being installed.
c. Review progress of VRF HVAC system(s) installation for strict compliance with manufacturer's requirements.
d. Advise and if necessary assist Installer with updating related refrigerant calculations and system documentation.
e. Issue a report for each visit, documenting the visit.

1) Report to include name and contact information of individual making the visit.
2) Date(s) and time frames while on-site.
3) Names and contact information of people meeting with while on-site.
4) Clearly identify and list each separate issue that requires resolution. For each issue, provide a unique identification number, relevant importance, specific location or equipment identification, description of issue, recommended corrective action, and follow-up requirements needed. Include a digital photo for clarification if deemed to be beneficial.

5. Final Inspection before Startup:

a. Before inspection, Installer to provide written request to manufacturer stating the system is fully installed according manufacturer's requirements and ready for final inspection.

b. All system equipment and operating components shall be inspected. If components are inaccessible for inspection, they shall be made accessible before the final inspection can be completed.

c. Manufacturer shall provide a comprehensive inspection of all equipment and each operating component that comprise the complete system(s). Inspection shall follow a detailed checklist specific to each equipment and operating component.

d. Inspection reports for indoor units shall include, but not be limited to, the following:

1) Unit designation on Drawings.
2) Manufacturer model number.
3) Serial number.
4) Network address, if applicable.
5) Each equipment setting.
6) Mounting, supports, and restraints properly installed.
7) Proper service clearance provided.
8) Wiring and power connections correct.
9) Line-voltage reading(s) within acceptable range.
10) Wiring and controls connections correct.
11) Low-voltage reading(s) within an acceptable range.
12) Controller type and model controlling unit.
13) Controller location.
14) Temperature settings and readings within an acceptable range.
15) Humidity settings and readings within an acceptable range.
16) Condensate removal acceptable.
17) Fan settings and readings within an acceptable range.
18) Unit airflow direction within an acceptable range.
19) If applicable, fan external static pressure setting.
20) Filter type and condition acceptable.
21) Noise level within an acceptable range.
22) Refrigerant piping properly connected and insulated.
23) Condensate drain piping properly connected and insulated.
24) If applicable, ductwork properly connected.
25) If applicable, external interlocks properly connected.

e. Inspection reports for outdoor units shall include, but not be limited to, the following:

1) Unit designation on Drawings.
2) Manufacturer model number.
3) Serial number.
4) Network address, if applicable.
5) Each equipment setting.
6) Mounting, supports, and restraints properly installed.
7) Proper service clearance provided.
8) Wiring and power connections correct.
9) Line-voltage reading(s) within acceptable range.

10) Wiring and controls connections correct.
11) Low-voltage reading(s) within an acceptable range.
12) Condensate removal acceptable.
13) Noise level within an acceptable range.
14) Refrigerant piping properly connected and insulated.
15) Condensate drain piping properly connected and insulated.

f. Inspection reports for indoor, dedicated outdoor air ventilation units shall include, but not be limited to, the following:

1) Unit designation on Drawings.
2) Manufacturer model number.
3) Serial number.
4) Network address, if applicable.
5) Each equipment setting.
6) Mounting, supports, and restraints properly installed.
7) Proper service clearance provided.
8) Wiring and power connections correct.
9) Line-voltage reading(s) within acceptable range.
10) Wiring and controls connections correct.
11) Low-voltage reading(s) within an acceptable range.
12) Controller type and model controlling unit.
13) Controller location.
14) Temperature settings and readings within an acceptable range.
15) Humidity settings and readings within an acceptable range.
16) Condensate removal acceptable.
17) Fan settings and readings within an acceptable range.
18) Fan external static pressure setting.
19) Filter type and condition acceptable.
20) Noise level within an acceptable range.
21) Refrigerant piping properly connected and insulated.
22) Condensate drain piping properly connected and insulated.
23) Automatic dampers properly installed and operating.
24) Ductwork properly connected.
25) If applicable, external interlocks properly connected.

g. Installer shall provide manufacturer with the requested documentation and technical support during inspection.
h. Installer shall correct observed deficiencies found by the inspection.
i. Upon completing the on-site inspection, manufacturer shall provide a written report with complete documentation describing each inspection step, the result, and any corrective action required.
j. If corrective action is required by Installer that cannot be completed during the same visit, provide additional visits, as required, until deficiencies are resolved and systems are deemed ready for startup.
k. Final report shall indicate the system(s) inspected are installed according to manufacturer's requirements and are ready for startup.

B. Perform the following tests and inspections with the assistance of manufacturer's service representative:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Refrigerant Tubing Positive Pressure Testing:

1. Comply with VRF HVAC system manufacturer's requirements.
2. Prepare test report to record the following information for each test:

a. Name of person starting test, company name, phone number, and e-mail address.
b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
c. Detailed description of extent of tubing tested.
d. Date and time at start of test.
e. Test pressure at start of test.
f. Outdoor temperature at start of test.
g. Name of person ending test, company name, phone number, and e-mail address.
h. Date and time at end of test.
i. Test pressure at end of test.
j. Outdoor temperature at end of test.
k. Remarks:

3. Submit test reports for Project record.

D. Refrigerant Tubing Evacuation Testing:

1. Comply with VRF HVAC system manufacturer's requirements.
2. Prepare test report to record the following information for each test:

a. Name of person starting test, company name, phone number, and e-mail address.
b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
c. Detailed description of extent of tubing tested.
d. Date and time at start of test.
e. Test pressure at start of test.
f. Outdoor temperature at start of test.

g. Name of person ending test, company name, phone number, and e-mail address.
h. Date and time at end of test.
i. Test pressure at end of test.
j. Outdoor temperature at end of test.
k. Remarks:

3. Submit test reports for Project record.
4. Upon successful completion of evacuation testing, system shall be charged with refrigerant.

E. System Refrigerant Charge:

1. Using information collected from the refrigerant tubing evacuation testing, system Installer shall consult variable refrigerant system manufacturer to determine the correct system refrigerant charge.
2. Installer shall charge system following VRF HVAC system manufacturer's written instructions.
3. System refrigerant charging shall be witnessed by system manufacturer's representative.
4. Total refrigerant charge shall be recorded and permanently displayed at the system's outdoor unit.

F. Products will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.9 STARTUP SERVICE

A. Engage a VRF HVAC system manufacturer's service representative to perform system(s) startup service.

1. Service representative shall be a factory-trained and -authorized service representative of VRF HVAC system manufacturer.
2. Complete startup service of each separate system.
3. Complete system startup service according to manufacturer's written instructions.

B. Startup checks shall include, but not be limited to, the following:

1. Check control communications of equipment and each operating component in system(s).
2. Check each indoor unit's response to demand for cooling and heating.
3. Check each indoor unit's response to changes in airflow settings.
4. Check each indoor unit, HRCU, and outdoor unit for proper condensate removal.
5. Check sound levels of each indoor and outdoor unit.

C. Installer shall accompany manufacturer's service representative during startup service and provide manufacturer's service representative with requested documentation and technical support during startup service.

1. Installer shall correct deficiencies found during startup service for reverification.

D. System Operation Report:

1. After completion of startup service, manufacturer shall issue a report for each separate system.
2. Report shall include complete documentation describing each startup check, the result, and any corrective action required.
3. Manufacturer shall electronically record not less than two hours of continuous operation of each system and submit with report for historical reference.

a. All available system operating parameters shall be included in the information submitted.

3.10 ADJUSTING

A. Adjust equipment and components to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature and humidity set points. Adjust initial airflow settings and discharge airflow patterns.

C. Set field-adjustable switches and circuit-breaker trip ranges according to VRF HVAC system manufacturer's written instructions, and as indicated.

D. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.11 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by manufacturer's authorized service representative. Include two service visits for preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper equipment and system operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.12 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.13 DEMONSTRATION

A. Engage a VRF HVAC system manufacturer's factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain entire system.

B. Instructor:

1. Instructor shall be factory trained and certified by VRF HVAC system manufacturer with current training on the system(s), equipment, and controls that are installed.

C. Schedule and Duration:

1. Schedule training with Owner at least 20 business days before first training session.
2. Training shall occur before Owner occupancy.
3. Training shall be held at mutually agreed date and time during normal business hours.

D. Location: Owner shall provide a suitable on-site location to host classroom training.

E. Training Attendees: Assume three people.

F. Training Attendance: For record purposes, document training attendees at the start of each new training session. Record attendee's name, signature, phone number, and e-mail address.

G. Training Format: Individual training modules shall include classroom training followed by hands-on field demonstration and training.

H. Training Materials: Provide training materials in electronic format to each attendee.

1. Include instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
2. Video record each classroom training session and submit an electronic copy to Owner before requesting Owner acceptance of training.

I. Acceptance: Obtain Owner written acceptance that training is complete and requirements indicated have been satisfied.

END OF SECTION

SECTION 23 84 13 - HUMIDIFIERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following humidifiers:
   1. Self-contained.

1.3 DEFINITION

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.4 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, wiring diagrams and accessories. Include piping details, plans, elevations, sections, details of components, manifolds, installation and attachments to other work.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For humidifiers to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Supply one replacement electrode cylinder with each self-contained humidifier

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with ARI 640, "Commercial and Industrial Humidifiers."

1.8 COORDINATION

A. Coordinate location and installation of humidifiers with manifolds in ducts and air-handling units or occupied space. Revise locations and elevations to suit field conditions and to ensure proper humidifier operation.

PART 2 - PRODUCTS

2.1 SELF-CONTAINED HUMIDIFIERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Condair.
2. Dri-Steem.
3. Approved equal with Seismic Certification.

B. Electric-Resistance Heater Container: Cleanable, ASTM A 666, Type 316 stainless steel. Comply with UL 499.

C. Electrode Cylinder: Replaceable plastic assembly with disposable ionic bed inserts. Comply with UL 499.

D. Furnish each unit with flexible steam hose(s) and condensate drain line(s) when the distance from the humidifier to the steam distribution tubes is 15 feet or less. When distance exceeds 15 feet, field provided insulated steel piping shall be used in lieu of the flexible lines.

E. Manifold: ASTM A 666, Type 304 stainless-steel tube extending across entire width of duct or plenum and equipped with mounting brackets on ends. Provide multi-tube distribution manifold for short absorption length.

F. Cabinet: Sheet metal enclosure for housing heater cylinder, electrical wiring, components, controls, and control panel. Enclosure shall include baked-enamel finish, hinged or removable access door, and threaded outlet in bottom of cabinet for drain piping.

G. Control Panel:

1. Factory-wired disconnect switch.
2. Liquid-crystal display.
3. Programmable keyboard.
4. Set-point adjustment.
5. Warning signal indicating end of replaceable cylinder life.
6. Low-voltage, control circuit.
7. Diagnostic, maintenance, alarm, and status features.
8. High-water sensor to prevent overfilling.

H. Controls:

1. Microprocessor-based control system for modulating or cycling control, and start/stop and status monitoring for interface to central HVAC instrumentation and controls.
2. Solenoid-fill and automatic drain valves to maintain water level and temper hot drain water.
3. Field-adjustable timer to control drain cycle for flush duration and interval.
4. Controls shall drain tanks if no demand for humidification for more than 72 hours.
5. Conductivity-type level controls.

I. Accessories:

1. Humidistat: Wall-mounting, solid-state, electronic-sensor controller capable of full modulation or cycling control.
2. Duct-mounting, high-limit humidistat.
3. Airflow switch for preventing humidifier operation without airflow.

J. Blowdown Cooler:

1. Provide each unit with a condensate blowdown cooler capable of reducing the temperature of the humidifier unit's blowdown and condensate waste to below 140°F before discharging into the plumbing drain.

K. Roof Mounted:

1. Provide enclosure & seismic legs, where roof mounted.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before humidifier installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install humidifiers with required clearance for service and maintenance. Maintain path, downstream from humidifiers, clear of obstructions as required by ASHRAE 62.1.

B. Seal humidifier manifold duct or plenum penetrations with flange.

C. Install humidifier manifolds in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

D. Provide duct reinforcing or support required for the humidifier body and distribution manifold(s).

E. Mount units in air handling units or ductwork as specified on the drawings. Provide additional duct reinforcing or support required for the humidifier body and distribution manifold(s). Install piping specialties and controls as detailed and in accordance with manufacturer's instructions.

F. Install piping specialties and controls in accordance with manufacturer's instructions. Provide make-up water lines and provide solenoid control and shutoff valves, coordinating final connection point with the Plumbing Contractor. Provide drain lines routed to the nearest drain location.

G. Install stainless-steel drain pan under each manifold mounted in duct per detail on drawings.

1. Construct drain pans with connection for drain; insulated and complying with ASHRAE 62.1.
2. Connect to condensate trap and drainage piping.
3. Extend drain pan upstream and downstream from manifold a minimum distance recommended by manufacturer but not less than required by ASHRAE 62.1.

H. Install manifold supply piping pitched to drain condensate back to humidifier.

I. When distance from humidifier unit to steam distribution tubes exceeds 15 feet, provide insulated steel piping in lieu of flexible lines. Lines shall be sized and installed in accordance with the unit manufacturer’s instructions and recommendations.

J. Insulate field provided piping in accordance with the unit manufacturer’s instructions and the requirements in Division 23 Section “HVAC Insulation”.

K. For roof mounted application, install steam generator level on base.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Install piping adjacent to humidifiers to allow service and maintenance.

B. Install electrical devices and piping specialties furnished by manufacturer but not factory mounted.

C. Install piping from safety relief valves to nearest drain.

D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

F. Mount the control humidistat where shown on the plans approximately 5 feet above floor level. Mount the high humidity cutout humidistat near the same location.

G. Pitch all steam lines and condensate drain lines back to the humidifier unit in accordance with the unit manufacturer’s instructions.

H. Provide required electrical control wiring.

I. All humidistats and high limit humidistats shall be mounted in lockable enclosures.

J. The entire system shall be installed and placed in operation in strict accordance with the unit manufacturer's instructions and recommendations.

3.4 FIELD QUALITY CONTROL

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain humidifiers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

Project Manual

100% Construction Documents

NEW CARDIAC CATHETERIZATION LAB SUITE & HYPERBARIC FACILITY EXPANSION RIVERSIDE UNIVERSITY HEALTH SYSTEM

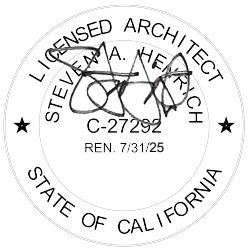
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Moreno Valley, CA 92555

HCAI #S231455-33-00

(Package 4 of 4: Sections 26 05 00 thru 28 13 00)

Leo A. Daly
Project No. 047-10071-002
October 10, 2023

SECTION 00 01 07 – SEALS PAGE

 Stamp & Signature of Architect of Record	 Stamp & Signature of Structural Engineer of Record
 Stamp & Signature of Mechanical Engineer of Record	 Stamp & Signature of Electrical Engineer of Record

REVIEWED IN ACCORDANCE WITH
THE REQUIREMENTS OF T24, CCR
APPROVED
Allen Cheng,Senior Architect
August 16, 2024
Department of Health Care Access and Information
FACILITIES DEVELOPMENT DIVISION

DIVISION 26

ELECTRICAL

SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Division 07 Section “Penetration Firestopping” for piping, conduit, and wiring penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies and smoke barriers.

C. Division 07 "Roof Accessories" and "Sheet Metal Flashing and Trim" for piping, conduit and equipment supports penetrating roofs, exterior walls and floors including flashings, curbs, sealants, clamps and vents.

1.2 SUMMARY

A. Section Includes:

1. Electrical equipment coordination and installation.

2. Flashing Materials.

3. Access Panels

4. Common electrical installation requirements.

1.3 DEFINITIONS

A. Code. National, State and Local Electrical codes including OSHA requirements.

B. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

C. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

D. Electrical ductbank: Assembly consisting of multiple electrical conduits embedded in earth or concrete.

E. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

F. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

G. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

H. Home Run: The portion of a branch circuit between the serving panelboard and the first electrical outlet, lighting fixture, or other electrical load connected to the circuit.

I. High voltage: 35,001 volts and greater.

J. Low voltage: 50 to 600 volts.

K. Medium voltage: 601 to 35,000 volts.

L. Provide. Furnish, install and wire ready for service.

M. Signal voltage. NEC class 1, 2, or 3 remote control, signaling, or power limited circuits.

1.4 SCOPE

A. Drawings and Specifications form complementary requirements; provide work specified and not shown, and work shown and not specified as though explicitly required by both. Although work may not be specifically shown or specified, provide supplementary or miscellaneous items, appurtenances, devices and materials obviously necessary for a sound, secure and complete installation.

B. It is the intent that these Specifications and associated Drawings establish minimum requirements for products and equipment with the intent to provide electrical service, distribution and systems finished, tested and ready for operation. Incidental detail that is not shown or specified, but necessary for proper installation and operation shall be included in the work and in these Contractor's estimates, the same as if specified. Locations of all equipment and material shall be adjusted at no extra cost to the Owner, to accommodate the work interferences anticipated and/or encountered. Prior to installation, determine the exact route and location of each raceway and piece of equipment to minimize conflicts with other trades.

C. This project will be phased, as defined by the Owner. This may necessitate the provision of temporary electrical utilities. All associated appurtenances with the utilities shall be provided as part of this project in the appropriate phase coordinated with Owner’s phasing requirements.

D. Information and components shown on riser diagrams but not shown on plans, and vice versa, shall be provided as if expressly required on both.

E. It is the requirement of these Contract Documents to have the contractors provide systems and components that are fully complete, operational, and suitable for the intended use.

There may be situations in the documents where insufficient information exists to precisely describe a certain component or subsystem, or the routing of a component or its coordination with other building elements. In cases such as this, where the Contractor has failed to notify the Architect of the situation in accordance with Paragraph (A) above, the Contractor shall include in their bid the specific components or subsystems with all parts necessary for the intended use, fully complete and operational, and installed in workmanlike manner either concealed or exposed per the design intent.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than 0 deg F or exceeding 104 deg F.

2. Humidity: Less than 95 percent (noncondensing).

3. Altitude: Not exceeding 6600 feet, or 3300 feet if equipment includes solid-state devices.

1.6 MODIFICATIONS IN LAYOUT

A. Drawings are intended to outline the scope of work required and are not intended to be installation drawings. Drawings are not intended to be absolutely precise; they are not intended to specify or to show every offset, fitting, and component nor do they show the exact routing and locations needed to coordinate with structure and other trades and to meet Architectural requirements. The purpose of the drawings is to indicate a systems concept, the main components of the systems, and the approximate geometrical relationships. Based on the systems concept, the main components, and the approximate geometrical relationships, the contractor shall provide all other components and materials necessary to make the systems fully complete and operational.

B. Unless specifically stated to the contrary, no measurement of an electric drawing derived by scaling shall be used as a dimension to work by. Dimensions noted on the electric drawings are subject to measurements of adjacent and previously completed work. Measurements shall be performed prior to the actual installation of equipment.

C. Prior to installation of visible material and equipment (including access panels) in finished spaces, review Architectural Drawings for desired locations and where not definitely indicated, request information from Architect.

D. Check Contract Documents, as well as Submittals and Shop Drawings of all subcontractors to verify and coordinate spaces in which work of Divisions 21 through 28 will be installed.

E. Make reasonable modifications in layout and components needed to prevent conflict with work of other trades. Systems shall be run parallel with or perpendicular to major architectural and structural building elements.

F. Where conflicts or potential conflicts exist and engineering guidance is desired, submit sketch of proposed resolution to Architect for review and approval.

1.7 COORDINATION

A. Coordinate arrangement, mounting, and support of equipment and raceways:

1. To maintain maximum headroom; all piping, duct, conduit, and associated components to be as tight as possible to underside of structure to provide for ease of disconnecting the equipment with minimum interference to other installations.

2. To allow right of way for piping installed at required slope.

3. To allow connecting raceways, cables, wireways, cable trays, and busways to be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

1.8 COORDINATION DRAWINGS

A. When included as part of the Contract Documents, there shall be full cooperation and coordination of all specialty trades.

B. This Division's contractors shall comply fully with the requirements set forth in the Division 23 Section "Coordination Drawings" specification section.

1.9 RECORD DOCUMENTS

A. Record Drawings are specified in Division 01 Section "Project Record Documents."

B. The Contractor shall keep a detailed up-to-date record, of the manner and location in which installations are actually made, indexing each feeder, pull box and protective device. Record documents are to reflect all changes in work including change orders, field directives, addenda from bid set of Contract Documents, request for information responses, etc. Upon completion of the project, the contractor shall modify the project electronic drawing and specification files to incorporate this information. Modified documents shall be turned over to the Owner in both electronic and hard paper copy formats. Record drawings shall also include:

1. Locations of buried conduit or similar items. Include buried depth.

2. Field changes of dimension or detail.

3. Details not on original contract drawings.

4. Changes to circuit numbers.

5. Junction box locations and conduit runs, with trade sizes indicated, for lighting, power, and electrical systems installed.

6. Final panel schedules on drawings matching construction document drawing size.

1.10 MAINTENANCE MANUALS AND OPERATING INSTRUCTIONS

A. Obtain at time of purchase of equipment, three copies of operation, lubrication and maintenance manuals for all items. Assemble literature in a coordinated manual using loose leaf sheets in a three-ring binder(s). Manual shall contain names and addresses of manufacturers and local representatives who stock or furnish repair parts for items or equipment.

B. The manuals shall include the following and shall have an index of contents and tabs for each Specification Section and each piece of equipment specified in that Section and be provided in the order listed below, per Specification Section.

1. Copies of all approved submittals/shop drawings.

2. Manufacturer's operating and maintenance instructions and parts lists of all items or equipment. Where manufacturer's data includes several types or models, the applicable type or model shall be clearly designated.

3. Startup and shutdown procedures.

4. Test records.

5. Wiring diagrams.

6. Lubrication instructions detailing type of lubricant, amount, and intervals recommended by manufacturer for each item of equipment.

7. Owner's written acknowledgement of satisfactory completion of instruction period.

C. Furnish three copies of manuals to Architect for approval and distribution to Owner. Deliver manuals no less than 30 days prior to acceptance of equipment to permit Owner's personnel to become familiar with equipment and operation prior to acceptance.

D. Operating instructions: Upon completion of installation or when Owner accepts portions of building and equipment for operational use, instruct Owner's operating personnel in any or all parts of all systems. Factory-trained personnel shall perform instructions.

1.11 SUBMITTAL PROCEDURE AND FORMAT

A. This Article supplements Division 1.

B. Submittal Cover Sheet

1. Submittal data for each product shall include a copy of the following cover sheet completely filled out. Incomplete or incorrect cover sheet submittal shall constitute reason for rejection.

2. Material submittals shall be organized by specification section. All items requiring a submittal per each specification section shall be combined into a single submittal. Provide each section/item within that submittal with its own cover sheet labeled and tagged to match the drawings.

SHOP DRAWING COVER SHEET				
PROJECT:		CONTRACTOR:		
DIVISION NO.:		SECTION NO.:		
DESCRIPTION:				
CONTRACT DRAWING REFERENCE NO:				
EQUIPMENT TAG:				
SUBMISSION (CIRCLE ONE): FIRST, SECOND, THIRD, FOURTH				
DATE:				
INFORMATION AND CHECKLIST				
1.	Contractor's Log #ID			
2.	Name, address, and phone number of supplier.			
3.	Are all specified or scheduled items included and exactly match scheduled/specified items?	Yes	No	
4.	Is this item a substitution?	Yes	No	
5.	Are deviations clearly identified?	Yes	No	
6.	Does equipment fit space shown on construction documents, coordination drawings, and actual field conditions?	Yes	No	
7.	Has support, erection, weights, and installation been coordinated with all trades?	Yes	No	
8.	Does the proposed installation void warranties and/or violate UL or code requirements?	Yes	No	
9.	Does this material/equipment add expense to any other trade or project costs?	Yes	No	
10.	Does equipment require interface with other trades? List divisions and specifics requiring coordination?	Yes	No	
11.	Is control interface coordinated?	Yes	No	
12.	List electrical characteristics (V/Ph/A)			

3. Multiple Re-submittals: The Engineer will review the first submittal from the contractor and respond with comments and will review one re-submittal for the same item(s) from the contractor and respond with comments. If the contractor is required to make subsequent submittals for the same item(s) the Engineer shall be compensated by the contractor for the time to review each subsequent re-submittal. The contractor shall agree to compensate the Engineer a minimum of $500 per each re-submittal item.

4. Shop Drawings showing layouts of systems shall contain sufficient plans, elevations, sections, details and schematics to describe work clearly. They shall be ¼" = 1'-0" scale unless specified otherwise.

5. Shop drawings and submittals showing manufacturer's product data shall contain detailed dimensional drawings, accurate and complete description of materials of construction, manufacturer's published performance characteristics and capacity ratings (performance data, alone, is not acceptable), electrical requirements and wiring diagrams. Drawings shall clearly indicate location (terminal block or wire number), voltage and function for all field terminations, and other information necessary to demonstrate compliance with all requirements of Contract Documents.

6. Provide shop drawing submittals showing details of electrical connections to ALL equipment. If connection details are not submitted and connections are found to be installed incorrectly in the field, this contractor shall reinstall them within the original contract price.

7. Shop drawings for different systems and equipment shall be bound separately by specification section as indicated above and not bound by manufacturer. Each separate submittal shall have its own transmittal and cover letter. Submittals which contain different specification section systems bound together shall be returned un-reviewed for re-submittal.

8. Lighting Fixture shop drawings shall consist of two submittals, one for interior lighting and one for exterior lighting. Each submittal shall have all associated light fixtures included. Separate submittals grouped by manufacturer or supplier shall not be accepted. The contractor shall be responsible for coordinating drawings from his various suppliers in order to comply with this requirement.

1.12 QUALITY ASSURANCE

A. Acceptable Manufacturers

1. The Engineer's design for each product is based on the manufacturer listed in the schedule or shown on the drawings. In Part 2 of some technical specifications, other manufacturers are listed as being acceptable. The listing of a manufacturer as acceptable does not imply automatic approval. It is the sole responsibility of the Contractor to ensure that any submittals made are for products that meet or exceed the specifications included herein. These are acceptable only if, as a minimum, they:

a. Meet all performance criteria listed in the schedules and outlined in the specification.

b. Have identical operating characteristics to those called for in the specification. For example, a two-stroke diesel generator will not be acceptable if a four-stroke model is specified.

c. Fit within the available space it was designed for, including space for maintenance and component removal, with no modification to either the space or the product. Clearances to walls, ceilings and other equipment will be at least equal to those shown on the design drawings. The fact that a manufacturer's name appears as acceptable shall not be taken to mean that the Engineer has determined that the manufacturer's products will fit within the available space - this determination is solely the responsibility of the contractor.

d. Products must adhere to all architectural considerations including but not limited to: being of the same color as the product scheduled or specified, fitting within architectural enclosures and details, and for diffusers, lighting and plumbing fixtures - being the same size and of the same physical appearance as scheduled or specified products.

B. All equipment shall be labeled or listed by the National Board of Underwriters Laboratories (U.L.) or other recognized listing/testing agency where such labeling or listing exists for such material.

C. Fire-Resistance Ratings: For piping, conduit, and wiring penetrations, provide penetration firestopping devices tested for fire resistance per ASTM E 814 by a testing agency acceptable to authorities having jurisdiction. Indicate design designations from UL's "Fire Resistance Directory."

1.13 NFPA 70 [NATIONAL ELECTRICAL CODE (NEC)][CALIFORNIA ELECTRICAL CODE (CEC)] COMPLIANCE

A. All electrical components, devices and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use. Skid-mounted or packaged assemblies shall be listed and labeled as an assembly, not just the individual components.

B. Division 26 installation by contractor shall be in accordance with and comply with the NFPA 70.

1.14 UTILITY CHARGES

A. The contractor shall be responsible for costs from electric utility company that are assessed the Owner for the installation of the permanent electric service. It is the

responsibility of the contractor to obtain those costs from the utility company and include them in their bid.

1.15 TEMPORARY CONSTRUCTION POWER

A. Provide temporary lighting and construction power for the project. Pay the usage charges to the serving utility for electric service associated with temporary lighting and power for construction.

B. CONTINUITY OF UTILITY SERVICES

1. In the absence of specific requirements in Division 1, comply with the following procedures for shutdowns.

a. Provide temporary services where project construction schedule requires extended shutdowns of existing equipment and/or systems. Temporary services include the necessary equipment and/or systems to maintain continuity of services. Extended shutdowns are interruptions of existing services for a period longer than that acceptable to the Owner.

b. Contractor shall coordinate any shutdowns of existing systems as follows:

c. Give proper notice to Owner when making shutdowns; a minimum of fourteen full days is required.

d. Minimize timeline of shutdowns of any system.

e. Provide temporary services where required and perform shutdowns and tie-ins at a time convenient to Owner.

2. Contractor shall be responsible for completing and filing the Owner's shutdown notice questionnaire.

3. Perform required survey and inspection work required by the notice for shutdown.

4. All life safety systems shall be returned to service at the end of each workday when work is being performed on the systems. It is the responsibility of the Contractor to provide all associated appurtenances necessary to ensure that the systems are in proper working condition at all times.

1.16 DELIVERY, STORAGE, AND HANDLING

A. Protect equipment/materials from damage during shipping, storage, handling, and installation. Delivery equipment/materials to the site in manufacturer’s original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

B. The Contractor shall provide for enclosed storage, when equipment/materials are stored on-site and prior to building "dry-in", to prevent any damage resulting from inclement weather or construction traffic. Specialties shall not be stored outdoors.

C. Equipment/materials, stored or installed, found to be damaged shall be replaced with new by the Contractor, to the satisfaction of the Owner and at no additional expense. Do not store equipment with PVC material with exposure to direct sunlight.

PART 2 - PRODUCTS

2.1 CEILING ACCESS AND ACCESS PANELS

A. Access panels are generally not shown on the drawings, but they are required to be provided by Contractor.

B. Access panels shall be of size required to provide adequate access to equipment. Minimum size shall be 12" X 12" for hand access or 24" X 24" for body access. Minimum 16-gauge frame, not less than 18 gauge hinged door panel. Door locks shall be screwdriver operated for panels in general location applications and shall be key locked for public area applications.

C. Furnish access panels for installation under other Sections valves or other items installed under this Division require access and are concealed in floor, wall, furred space or above ceiling. Access panels shall be by Milcor, Knapp, Nystorm or Inland Steel; coordinate selection with other Sections supplying similar access panels. Color of panel shall be selected by the Architect.

D. Panels shall include concealed hinges, cam type locking devices, and shall have a frame border type necessary for the particular wall or ceiling construction in which they are installed. Access panels shall be flush mounted, recessed frame type units. Access panels shall be prime coated steel, for field painting for general applications and stainless steel for use in toilet rooms, shower rooms, and similar wet locations.

E. Access panels shall have same fire rating classification as surface penetrated. Rated access panels must have U.L. Label.

2.2 FLASHING MATERIALS

A. All piping, conduit and equipment supports through roofs shall be flashed. Flashing materials and methods shall be in accordance to the roof manufacturer's and Division 07 requirements.

PART 3 - EXECUTION

3.1 PRE-BID SITE VISIT

A. Before submitting bid, visit and carefully examine site to identify existing conditions and difficulties that will affect work of this division. No extra payment will be allowed for additional work caused by unfamiliarity with site conditions that are visible or readily construed by an experienced observer.

B. Contractor shall visit job site to familiarize himself with the specific location of the new equipment installations in existing areas, to ensure there is adequate access for the installation of equipment. All entries, pathways, corridors, stairwells, etc., that may be used to install equipment shall be investigated. All existing conditions and potential obstructions that may impede access and installation shall be addressed prior to equipment purchasing/ordering.

C. The documentation of existing conditions was derived from As-Built documents and are in part unverified. Actual existing conditions shall be verified prior to commencement of work.

3.2 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1 – Standard Practices for Good Workmanship in Electrical Contracting.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

F. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe, conduit, and wiring penetrations. Seal penetrations with fire- and smoke-stop materials. Refer to Division 07 for firestopping and fill materials.

G. Waterproof Penetrations: Maintain integrity of waterproof roof, wall and floor penetrations for pipe, conduit and equipment support penetrations. Seal penetrations with waterproof materials with clamps, sleeves, flashings, pipe boots and/or pipe curb

assemblies as detailed or specified. Refer to Division 07 for waterproofing methods and materials when not specified in this section.

3.3 CONCRETE BASES

A. Provide raised concrete base for all floor mounted electrical equipment, including but not limited to, switchboards, transformers, motor control centers, transfer switches, lighting control/dimmer cabinets, and motor controllers.

B. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes (if applicable) at Project. Where specific requirements are not specified in Division 3 or detailed on the Drawings, comply with the following at a minimum:

1. Construct concrete bases 4 inches high unless otherwise indicated; and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated.

2. Edges of concrete bases shall have a minimum 1-1/2-inch chamfer.

3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.

4. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

5. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

6. Cast anchor-bolt insert into bases. Install anchor bolts to elevations required for proper attachment to supported equipment.

7. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

8. Use 3000-psi, 28-day compressive-strength concrete with wire-mesh reinforcement.

3.4 FIREPROOFING

A. Clips, hangers, clamps, supports and other attachments to surfaces to be fireproofed shall be installed, insofar as possible, prior to start of spray fiber work.

B. Piping and other items which would interfere with proper application of fireproofing shall be installed after completion of spray fiber work.

C. Patching and repairing of fireproofing due to cutting or damaging to fireproofing during course of work specified under this Section shall be performed by installer of fireproofing and paid for by trade responsible for damage and shall not constitute grounds for extra cost to Owner.

3.5 INSTALLATION ONLY ITEMS

A. Where this contractor is required to install items which he does not purchase, he shall coordinate their delivery and be responsible for their unloading from delivery vehicles and for their safe handling and field storage up to the time of installation. This contractor shall be responsible for:

1. Any necessary field assembly and internal connections, as well as mounting in place of the items, including the purchase and installation of all dunnage supporting members and fastenings necessary to adapt them to architectural and structural conditions.

2. Their connection to building systems including the purchase and installation of all terminating fittings necessary to adapt and connect them to the building systems.

B. This Contractor shall carefully examine such items upon delivery. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of work of this Contractor will be considered only if presented in writing within one week of their date of delivery. Unless such claims have been submitted, this Contractor shall be fully responsible for the complete reconditioning or replacement of the damaged items.

3.6 PAINTING

A. Furnish one can of aerosol-free touch-up paint for each different color factory finish which is to be the final finished surface of the product.

3.7 CLEANING

A. Cleaning shall be performed prior to equipment being energized.

B. Raceways

1. General:

a. Cover all raceway openings prior to the installation of conductors to prevent dirt, moisture, and other debris from entering the raceways.

b. Before pulling conductors, swab out all raceways to remove any debris that may have entered raceways during construction or during storage.

c. When external surfaces of raceways or enclosures are rusted, clean and restore surfaces to original condition.

2. Equipment

a. After completion of work but prior to turning equipment over to the Owner, clean the exterior surfaces to be free from concrete residue, dirt, paint residue, etc.

b. All dirt, drywall dust, and all other foreign matter shall be blown from, wiped away, or vacuumed from transformer coils, terminal devices, panelboard interiors, switchboard interiors, junction boxes, pullboxes, and other similar equipment enclosures.

c. Thoroughly clean equipment of all stains, paint spots, dirt, and dust. Remove all temporary labels not used for instruction or operation and remove all visible trade labels.

3.8 COMMISSIONING

A. The Commissioning Authority will be Owner furnished and under direct contract with the Owner. That is, the General Contractor and this subcontractor's bid price shall not include the services of the Commissioning Authority but shall include costs for coordination testing, Contractor commissioning, etc.

3.9 CONTAINMENT ROOM SEALING REQUIREMENTS

A. General

1. Work that penetrates or is mounted on ceilings, walls, floors, or other surfaces throughout containment rooms shall be sealed as outlined below in addition to sealing specified elsewhere in the Specifications.

2. Completely seal the perimeter joints around all insulated and uninsulated penetrations and surface-mounted items.

B. Products

1. Acceptable sealant materials shall be products that conform to ASTM C920 "Specifications for Elastomeric Joint Sealants". Sealant shall adhere to substrates and maintain seal under normal expected movements of substrates.

2. Sealant specified herein shall be 732-RTV silicone rubber as manufactured by Dow Chemical Co. or equivalent by GE. Color shall be clear.

C. Installation

1. Preparation, priming (as applicable), application, curing and protection of the sealant shall be in conformance with the recommendations of the sealant manufacturer.

2. If necessary, fill voids with backer rods as recommended by the sealant manufacturer.

3. Mask edges of exposed joints if required to make neat joints and prevent excessive misplacement of sealant onto exposed surfaces adjacent to joints.

4. Perform sealant work after adjacent painting work is complete and dry.

5. Sealant shall be free of voids, be applied in one continuous bead and be tooled concave and smooth.

END OF SECTION

SECTION 26 05 10 - SELECTIVE ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:

1. Disconnection of power to selected portions of building or structure.

2. Demolition and removal of selected electrical components.

3. Salvage of existing items to be reused or recycled.

B. Related Requirements:

1. Division 01 Section "Cutting and Patching."

2. Division 02 Section "Selective Structure Demolition" for sequencing and scheduling procedures and requirements for demolition activities.

1.3 JOB CONDITIONS

A. Perform all demolition as needed to accomplish new work.

B. Do not rely solely on electrical drawings to determine extent of general construction demolition. Refer to architectural demolition plans for the exact extent of general construction demolition required by this contract.

C. This Contractor is responsible for all charges, fees etc. incurred as a result of the electrical portion of the demolition.

D. Prior to demolition or alteration of structures, the following shall be accomplished:

1. Review available record documents of the existing construction. Owner does not guarantee that existing conditions are same as those indicated in record documents.

2. Coordinate sequencing with Owner and other Contractors.

3. Coordinate means to separate construction zones from non-renovated zones to prevent the spread of dust, fumes and debris.

4. Coordinate means to provide exhaust and makeup air to maintain the construction zone at an adequate negative pressure to contain all construction dust and fumes.

5. Except as noted otherwise, remove from the premises, all materials and equipment removed in the demolition work.

6. Equipment noted to be removed and turned over to the Owner, shall be delivered to the Owner at a place and time he so designates.

7. Where the materials are to be turned over to the Owner or reused and installed by the Contractor, it shall be the Contractor's responsibility to maintain the condition of the materials and equipment equal to that existing before work began. Damaged materials or equipment shall be repaired or replaced at no additional cost to the Owner.

8. Survey and record condition of existing facilities to remain in place that may be affected by demolition operations. After demolition operations are completed, survey conditions again and restore existing facilities to their pre-demolition condition, at no additional cost to Owner.

9. Salvage equipment scheduled for reuse in new work or scheduled to be delivered to Owner's storage facility.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 PREPARATION

A. Survey existing conditions and correlate with requirements indicated to determine the extent of selective demolition required.

B. Refer to demolition drawings of other trades. Where motors, control panels, and other loads that have an electrical connection are being removed, include the disconnection and removal of associated electrical feeds, circuits, and lose control equipment in this contract.

C. Protect existing work to remain in place, to be reused, or to remain property of Owner.

D. Protect existing services and utilities.

E. Disconnect electrical systems in walls floors and ceilings scheduled for removal.

F. Coordinate utility service outages with serving utility company.

G. Provide temporary wiring and connections to maintain existing circuits in service during construction.

H. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switch overs and connections. Obtain permission from Owner and Architect at least 24 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service to areas adjacent to work areas as required.

3.2 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Beginning of demolition means installer accepts existing conditions.

B. Existing electrical equipment in conflict with new construction shall be removed and/or relocated as indicated on the drawings, as directed or needed. This Contractor shall remove all electrical equipment released from service as a result of construction, and no equipment removed shall be reused, except as specifically directed on the drawings or elsewhere herein. All mechanical components shall be stored on site for Owner assessment. Any components not retained by the Owner shall be removed by the contractor. Properly dispose or remove from site any items not retained by Owner.

C. Any existing services or equipment not shown on the drawings and which are logically expected to be continued in service and which may be interrupted or disturbed during construction, shall be reconnected in an approved manner. Provide temporary power connections, lighting, controls, etc., as needed to prevent interruption of service to occupied areas caused by demolition operations. In addition, any conduit, wiring, fixtures, or equipment which may require relocation or rerouting as a result of construction, shall be considered a part of the work of this section and shall be done by this Contractor with no additional compensation, provided that the referenced relocation is discernable from the pre-bid review of the site, and associated documents.

D. Verify circuiting arrangements are as shown on Drawings.

E. Verify that abandoned wiring and equipment serve only abandoned facilities.

F. Report discrepancies to Architect before disturbing existing installation.

G. De-energize, disconnect, demolish, and remove electrical systems, equipment, raceways, wiring, and components indicated to be removed.

H. Conduit to Be Removed: Remove portion of piping indicated or specified to be removed. In general, all empty raceways and associated supporting devices shall be removed back to nearest active junction box, panelboard, switchboard, panel cabinet, or other similar enclosure.

I. Conductors to be Removed: Unless specifically stated elsewhere, all un-terminated conductors shall be de-energized, and all de-energized conductors shall be removed back to source.

J. Equipment to be Removed, Including Panelboards and Distribution Equipment: De-energize, disconnect associated raceways and wiring, and remove equipment.

K. Equipment to Be Removed and Reinstalled: De-energize, disconnect associated raceways and wiring, and remove equipment. Clean equipment and store where appropriate, reinstall, reconnect, and make equipment operational. Test equipment and associated components in accordance with the appropriate specification section.

L. Equipment to Be Removed and Salvaged: De-energize, disconnect associated raceways and wiring, and move equipment to on site storage area as designated by the Owner.

M. Any unused conduit openings in junction boxes, panelboards, switchboards, panel cabinets, pull boxes, or other similar enclosures shall be covered in a code approved manner.

N. Update any electrical circuit directories or breaker identification nameplates to reflect changes in the status of overcurrent devices resulting from demolition.

O. Update circuit designations on any junction boxes where feeders and/or circuits were removed to properly indicate remaining circuits in junction boxes.

P. Disconnect and remove abandoned luminaires. Remove brackets, stands, hangers, and other accessories.

Q. Contractor shall check the ballasts of light fixtures removed from service. If any ballasts contain PCB's those ballasts shall be stored on site in containers and in a manner approved by local authorities and the Environmental Protection Agency. The contractor shall be responsible for disposal of ballasts that contain PCB's in an EPA-approved chemical waste processing plant in accordance with federal, state, and local requirements.

R. Notify Architect of location and extent of existing piping, conduit, OR equipment that interferes with new construction. In coordination with and with approval of Architect, relocate conduit and equipment to permit new work to be provided as required by Contract Documents. Remove non-functioning and abandoned conduit and equipment as directed by Architect. Dispose of or store items as requested by Architect.

S. Outlet boxes being abandoned in existing walls in remodeled areas shall have opening patched to match existing wall finish. Blank covers are not acceptable.

T. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

U. Maintain continuity of circuits that remain in service.

V. During the demolition and alterations, the fire alarm system, exit lighting and corridor life safety lighting shall remain active.

W. The fire alarm zone serving smoke detectors in the smoke compartment where work is occurring may be disconnected when work is taking place to avoid false alarms. Zone shall be reconnected at end of each workday. Smoke detectors shall be protected to keep dust and dirt from entering sensing chamber. All smoke detectors within the smoke compartment where work is occurring shall be cleaned upon completion of work within that area.

X. Existing conduit and wiring in remodeled area that is not being removed, but which will be in conflict with new HVAC duct work being installed, shall be rerouted as required.

Y. This Contractor shall provide required additional support for existing conduit in remodeled area that is not being removed and is not properly supported in accordance with NEC requirements.

Z. When existing ductwork, piping, or related equipment in remodeled areas prevents the installation of other work, remove and reinstall existing materials, making necessary modifications and transitions to coordinate with other trades.

3.3 CLEANING AND REPAIR

A. Clean existing materials and equipment which remain or are to be reused. Report damage or defects to Architect

B. Existing Panelboards: Clean exposed surfaces and check tightness electrical connections. Provide closure plates for vacant positions.

C. If equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

D. Repair adjacent construction and finishes damage during demolition and extension work.

E. Luminaires: Clean existing luminaires shown to be reused. Use mild detergent to clean interior surfaces and visible exterior surfaces, rinse with clean water and wipe dry. Replace lamps. Energize fixtures. Notify Architect of fixtures with faulty components.

END OF SECTION

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For all 2 hour rated assemblies, drawings shall be submitted indicating methods used to provide required 2 hour rated protection.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.5 PROJECT CONDITIONS

A. Wire and cable routing where shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project Conditions.

B. Where wire and cable routing are not shown, and destination only is indicated, determine exact routing and lengths required.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Belden, Inc.
2. Cerro Wire.
3. General Cable Technologies Corporation.
4. Priority Wire & Cable, Inc.
5. Southwire Company.
6. WESCO
7. AFC Cable Systems, Inc.

B. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

C. Copper Conductors: Comply with NEMA WC 70. Aluminum not permitted.

D. Conductor Insulation:

1. Type THHN/THWN-2: Comply with UL 83.
2. Type XHHW-2: Comply with UL 44.

E. Multiconductor Cable: Comply with NEMA WC 70 for metal-clad cable, Type MC and Type SO with ground wire.

2.2 HOSPITAL GRADE METAL-CLAD CABLE, TYPE MC (LIMITED USE ALLOWED)

A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath with two means of grounding. Armor plus full-sized aluminum ground conductor and full-sized green insulated copper grounding conductor.

B. Hospital Grade listed for use in patient care areas.

C. Comply with UL 1569.

D. Conductors: Copper for phase, neutral, and insulated ground. Aluminum for equipment ground.

E. Conductor Insulation:

1. Type THHN: Comply with UL 83.

F. Armor: Lightweight Green Steel or Aluminum, interlocked.

G. Minimum Conductor Size: 12 AWG.

H. Ground Conductor: Green Insulated, same size as current carrying conductors contained in the cable assembly.

I. Equipment Ground Conductor: Combined interlocked armor and full-sized bare aluminum grounding/bonding conductor.

J. Neutral Conductors: Dedicated neutral per phase (circuit) conductors contained in the cable assembly.

K. Cable terminators:

1. Malleable iron or aluminum with red plastic, internal, anti-short bushings.

2.3 SPECIALIZED CONDUCTORS AND CABLES

A. Conductors for motors served by VFDs: Where conductors from VFD to motor are run in PVC conduit conductors shall be listed for wet locations and shielded equal to Belden Cat#295XX or LAPP OLFLEX VFD 2XL and size as indicated on equipment schedules. Where conductors from VFD to motor are run above grade in metallic conduit, standard, allowed wiring methods (non-shielded conductors) shall be allowed.

2.4 CONNECTORS AND SPLICES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.
6. Thomas & Betts.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

C. Spring wire connectors: Corrosion-resistant, live-action spring in insulated shell, rated 105°C.

1. Non spring type connectors **shall not** be used and will be contractor's expense to replace if used.

D. Connectors and lugs: Circumferential compression (non-indenter) type.

2.5 2-HOUR FIRE RATED ASSEMBLIES

A. 2-hour rated assembly shall be achieved by one of the following conditions:

1. Be installed in spaces or areas that are fully protected by an approved automatic fire suppression system. Feeders installed above a suspended ceiling, to be considered protected, must be provided with sprinklers above the ceiling.

2. Be a listed electrical circuit protective system with a minimum 2-hour rated fire rating.
3. Be protected by a listed thermal barrier system for electrical system components with a minimum 2-hour fire rating.
4. Be protected by a listed fire-rated assembly that has a minimum of 2 hours and contains only emergency wiring.
5. Be encased in a minimum of 2" of concrete.

B. Acceptable means to achieve fire rated assembly. All FHIT means shall be verified for most current version prior to procurement:

C.

FHIT System	**Company**	**Product**
System No. 120	RSCC	2hr MC Cables
System No. 1850	PENTAIR	2hr MI Cables
System No. 25A	Draka	2hr RHW-2
System No. 25B	Draka	2hr RHW-2
System No. 25C	Draka	2hr RHW-2
System No. 28A	RADIX WIRE	2hr FPL
System No. 28B	RADIX WIRE	2hr FPL
System No. 28C	RADIX WIRE	2hr FPL
System No. 34	3M COMPANY	2hr Fire Barrier
System No. 38	THERMAL CERAMICS INC	1 and 2hr Fire Barrier
System No. 39	SPECIFIED TECHNOLOGIES INC	2hr Fire Barrier
System No. 40	COMTRAN CABLE L L C	2hr FLP
System No. 40A	COMTRAN CABLE L L C	2hr FLP
System No. 40B	COMTRAN CABLE L L C	2hr FLP
System No. 41	SPECIFIED TECHNOLOGIES INC	2hr Fire Barrier
System No. 50	Draka	2 hr MC Cables

D. All systems shall be installed per the FHIT guidelines and manufacturer's specifications.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. General:

1. Homeruns are defined from panelboard or source of power to junction box in room or space where devices are being served or to the device itself.

B. Feeders:

1. Conductors: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
2. Insulation: Type XHHW-2 insulation for feeders larger than #2 AWG; Type THHN/THWN-2 insulation for feeders #2 AWG and smaller.

C. Branch Circuits:

1. Conductor: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
2. Insulation: Type XHHW-2 insulation for branch circuits larger than #2 AWG; Type THHN/THWN insulation for branch circuits #2 AWG and smaller.

D. Copper Feeders only allowed to motors and equipment connections subject to vibration (including generators, fire pumps, HVAC equipment, etc.): Copper. No. 12 AWG and larger, stranded conductor, single conductor.

E. Use stranded conductor, single conductor, No. 14 minimum for control wiring.

F. Metal Clad Cable – Type MC

1. MC Cable may be used at the contractor's option for branch circuits between devices and for switching circuits.
2. Uses not permitted.

a. Homeruns: Circuit homeruns shall be individual wires in approved raceways.
b. Branch wiring in inaccessible ceilings.
c. Wiring runs exposed in unfinished spaces.
d. Exposed Front of House spaces or any exposed spaces within public view.
e. For circuits crossing smoke walls.
f. In exterior locations, or where exposed to view except in electrical rooms.
g. Emergency or Legally required circuits.

3. MC cable shall not terminate in Panelboards, Disconnects, Motor Controllers, Variable Speed Drives, Electrical Cabinets, Fire alarm panels, etc.
4.
5. Support metal clad cables above accessible ceilings using clips or cable ties. Do not rest cables on ceiling panels.
6. Do not support metal clad cables from cable tray, from mechanical ducts or equipment, or from ceiling support wires.
7. Install products in accordance with manufacturer's instructions.
8. Other restrictions as listed in the NEC and other applicable codes.
9. Hospital grade MC cable to be used in all patient care areas and where required by code.

G. All conductors for isolated power circuits shall be copper stranded with a cross-linked polyethylene insulation or equivalent with a dielectric constant of 3.5 or less. Minimum

insulation wall thickness shall be 4/64" for #10 and #12 AWG and 5/64" for #8 AWG and larger conductor. Under no circumstances shall wire pulling compound be used when pulling the wire for isolated power circuits.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Single conductors in raceway.

B. Exposed Feeders: Single conductors in raceway.

C. Feeders, Branch Circuits, and Control Wiring Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Single conductors in raceway, MC Cable allowed for Branch Circuits.

D. Feeders, Branch Circuits, and Control Wiring Concealed in Concrete, below Slabs-on-Grade, and Underground: Single conductors UL rated for wet locations in raceway.

E. Feeders, Branch Circuits, and Control Wiring Installed below Raised Flooring: Single conductors in raceway, MC Cable allowed for Branch Circuits.

F. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, above ceilings, and in floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed conduits parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

E. Neatly train and lace wiring inside boxes, equipment, and panelboards.

F. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

G. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

3.4 FEEDER REQUIREMENTS

A. Contractor shall provide lugs, compression fittings, auxiliary wireways, etc., of adequate size for termination of feeder sizes as indicated on drawings. Feeder sizes indicated may be oversized for voltage drop in some cases. Contractor shall coordinate with equipment manufacturer for proper lug sizes.

B. Extend feeders at full capacity from origin to termination.

C. Feeders shall be continuous, without splices in so far as, practical. All feeder splices not specifically indicated on drawings must be prior approved by engineer in writing before splicing any cable.

D. Each conduit raceway shall contain only those conductors constituting a single feeder circuit.

E. Where multiple raceways are used for a single feeder, each raceway shall contain a conductor of each phase and neutral, if used, and a grounding conductor.

F. Where feeder conductors are run in parallel, conductors shall be of same length, same material, circular-mil area, insulation type, and terminated in same manner.

G. Where parallel feeder conductors are run in separate raceways, raceways shall have same physical characteristics.

H. Feeders shall follow most accessible routes, concealed in construction in finished areas, exposed to the minimum temperature gradient and to minimum temperature fluctuation.

I. Confine feeders to insulated portions of building, unless otherwise shown.

J. Trapped runs without facilities for continuous drainage are not acceptable.

K. Do not draw conductors into conduits until building is enclosed and watertight and until work which may cause cable damage has been completed.

L. Feeders shall be sized for a maximum voltage drop of 2%.

3.5 2-HOUR FIRE RATED ASSEMBLIES

A. Conductor type used shall be continuous from origination to termination. No mixing and matching of conductor types shall be used to avoid unnecessary splices.

B. All splices shall be made in an approved junction/pull box maintaining the required 2-hour rating by using approved FHIT methods.

C. Installation shall comply with NEC 728.

D. All NFPA 70 Article 700 feeder circuit wiring shall be installed with a wiring method as required by code which may include 2-hour rated assemblies.

E. Feeders from an on-site stand-by generator to a fire pump controller shall be installed with a wiring method as required by code which may include 2-rated assemblies.

F. All branch circuits, feeders and associated control wiring serving stairwell pressurization fans, or elevator shaft pressurization fans, where run within building, shall be run with a wiring method as required by code which may include 2-hour rated assemblies.

1. Run circuits for these systems underground where possible and within the associated 2-hour shaft where possible.

3.6 BRANCH CIRCUIT REQUIREMENTS

A. Do not use wire smaller than No. 12 AWG (unless otherwise noted) for branch circuit wiring, including motor circuits. All 20 amp, 120 volt and 277 volt branch circuit homeruns (to panelboard) serving receptacles, and lighting shall be No. 10 AWG minimum to first outlet or light fixture.

B. Size homeruns for 120V branch circuits based on the overall circuit length to the furthest outlet. The following requirements shall be followed:

1. 0 to 100 ft. circuit length: Size homerun at #10 AWG minimum to first outlet.
2. 101 to 150 ft. circuit length: Size homerun at #8 AWG minimum to first outlet.
3. 151 to 250 ft. circuit length: Size homerun at #6 AWG minimum to first outlet.
4. For other branch circuits, size conductors so that voltage drop does not exceed 3%.

C. All 120 volt and 277 volt branch circuits shall have a dedicated neutral conductor for each circuit.

D. The plans show a circuit number for each device or light. This is done for clarity. No more than three 120V or 277 circuits shall be allowed in a single homerun raceway.

E. For isolated ground receptacle circuits, provide a dedicated neutral conductor and a dedicated isolated ground conductor for each circuit.

F. Any branch circuit protected by a GFCI circuit breaker shall be provided with a dedicated neutral conductor.

3.7 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

1.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

D. Clean conductor surfaces before installing lugs and connectors.

E. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

F. Use compression connectors for conductor splices and taps, 6 AWG and larger. Use compression tool designed for the size and type of connector being compressed. Tape uninsulated conductors and connector with electrical tape to 150% of insulation rating of conductor.

G. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 8 AWG and smaller.

H. Where oversized conductors are called for (due to voltage drop, etc.) provide/install lugs as required to match conductors, or provide/install splice box, and splice to reduce conductor size to match lug size.

3.8 MOTOR AND EQUIPMENT WIRING

A. Furnish and install motor circuits in accordance with schedules on drawings and code requirements, from source of supply to associated motor starter, and from starter to motor terminal box, including necessary and required intermediate connections.

B. Conductor and conduit size for motor branch circuits, if shown on drawings, are sized for motor requirement only. Contractor may, at his option, include associated control conductors in same conduit providing the conduit size is adjusted to meet code requirements for percentage of fill.

C. Motors shall have proper size wire as per applicable codes and nameplate ratings. Verify ratings of motors before installing wiring.

D. Obtain manufacturer's wiring diagrams of electrical equipment furnished with equipment and do not proceed to wire equipment without this information.

E. Before installing raceways and pulling wire to any mechanical equipment, verify electrical characteristics with final submittal on equipment to assure proper number and AWG of conductors. (As for multiple speed motors, different motor starter arrangements, etc.).

F. Make equipment connections with flexible conduit or liquid-tight flexible metallic conduit. Properly ground non-current carrying metal parts of equipment. Where cord connections

or receptacles are required, provide type "S" rubber jacketed cord, 600 volt, heavy duty service of sizes and lengths required, and receptacle as applicable.

G. Coordinate work with the other trades such that the operation of mechanical equipment will be as described in mechanical specifications.

H. Unless otherwise indicated on drawings or in specifications, motors shall be furnished, set in place, and connected to driven equipment and prepared for operation as specified in other sections. Provide final connection and proper phase relationship to achieve proper motor rotation.

3.9 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.10 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test conductors feeding the following critical equipment and services for compliance with requirements.

   a. Medical Imaging Equipment

   b. Isolated Power Panels

2. Visual and Mechanical Inspection

   a. Compare cable data with drawing and specifications
   b. Inspect exposed sections of cables for physical damage and correct connection in accordance with single-line diagram.
   c. Inspect bolted electrical connections for high resistance. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer’s published data.
   d. Inspect compression-applied connectors for correct cable match and indentation.

e. Inspect for correct conductor identification and phase arrangements.
f. Inspect jacket insulation and condition.

3. Electrical Tests

a. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Test duration shall be one minute.

1) Test and document all combinations of Phase to Phase, Phase to Ground, Phase to Neutral, and Neutral to Ground. Should contractor not test all combinations, contractor shall retest at contractor's expense.
2) Submit prior to energizing equipment for approval.

b. Perform continuity tests to insure correct cable connection.
c. Uniform resistance of parallel conductors.

4. Test Reports: Prepare a written report to record the following:

a. Test procedures used.
b. Make and model of test equipment used, including last calibration date (calibration date must be within the last 12 months)
c. Test results that comply with requirements.
d. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

C. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment

ACTION SUBMITTALS

B. Product Data: For each type of product indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:

1. Test wells.
2. Chemically Enhanced Main Service Ground
3. Ground rods.
4.
5. Grounding arrangements and connections for separately derived systems.
6. Grounding for sensitive electronic equipment.

B. Qualification Data: For qualified testing agency and testing agency's field supervisor.

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Instructions for periodic testing and inspection of grounding features at test wells, ground rings, and grounding connections for separately derived systems based on NETA MTS.

a. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
b. Include recommended testing intervals.

2. NFPA 99 grounding test results for patient care areas.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Grounding Bus: Predrilled rectangular bars of [1/4 inches] annealed copper, minimum [4 by 20 inches] in main electrical rooms and minimum [4 by 10 inches] in all other areas, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891, 600 V. Lexan or PVC, impulse tested at 5000 V.

2.2 CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Panduit – Irreversible compression connectors.

2. Erico – Welded connectors.

B. Listed and labeled by a NRTL acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

C. Bolted Connectors for Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

D. Welded Connectors: Exothermic-welding kits, low-emission, electric-starting types and of types recommended by kit manufacturer for materials being joined and installation conditions.

E. Compression Connectors: Irreversible type meeting IEEE standard 837-2002 and UL listed.

F. Compression-Type Bus-Bar Connectors: Copper or copper alloy, long-barrel, two-bolt connection to ground bus bar.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.
1.

B. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

C. Grounding Bus: Install in all electrical and low voltage communication, AV, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus bar on insulated spacers 1 inch, minimum, from wall 18 inches above finished floor, unless otherwise indicated.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors.
3. Connections to Ground Rods at Test Wells: Welded connectors.
4. Connections to Structural Steel: Welded connectors.

5. Aboveground Accessible Connections: Irreversible compression or welded connectors.
6. Connections in areas that may be a fire hazard to use welded connectors: Irreversible compression connectors.

3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits. Terminate each end on suitable lug, bus or bushing.

B. Bond equipment grounding terminal bars of the normal and emergency electrical system panelboards that serve the same patient area with an insulated continuous copper conductor not smaller than 8 AWG.

C. Panelboards serving "critical care" areas shall be grounded in accordance with NFPA 70 Article 517-19 (d). Metal feeder raceways shall have grounding bushing and a continuous copper bonding jumper sized in accordance with NFPA 70, Table 250-122.

D. Provide grounding and bonding in patient care areas to meet requirements of NFPA 99 and Regulatory Requirements.

E. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide insulated grounding conductor in raceway (minimum 3/0 AWG) from the main service copper bus bar to each service location(s), terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a copper grounding bus.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
3. Bond all cable tray, metallic conduits, and equipment racks with minimum 6 AWG to copper bus bar.

3.3 INSTALLATION

A. Install Products in accordance with manufacturer's instructions and NECA 331.

B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts. Bond together metal siding not attached to grounded structure and bond to grounding electrode system.

2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

D. Grounding and Bonding for Piping:

1. ALL metal piping within building shall be bonded in accordance with NFPA 70.
2. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
3. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
4. Bond each above ground portion of gas piping system downstream from equipment shutoff valve.

E. Grounding and Bonding for dry type transformers:

1. Step-down transformer secondaries shall be grounded to the nearest electrical room ground bus bar. Also, bond the grounded conductor of the transformer to the nearest available point of the interior metal water piping system in the area served by the transformer in accordance with NEC Article 250-104.

F. Grounding for Steel Building Structure:

1. Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.
2. Install insulated copper grounding conductor in conduit from main electrical service copper bus bar to building structural steel.

3.4 TERMINATIONS AND CONNECTIONS

A. Make terminations and connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

E. Test Wells: Use exothermic welded connections.

F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

G. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.5 LABELING

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.

B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.

1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

1. Manufacturer's Field Service – Electrolytic Grounding System: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells , and at individual ground rods. Make tests at ground rods before any conductors are connected.

   a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
   b. Perform tests by fall-of-potential method according to IEEE 81.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

D. Grounding system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

F. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm(s).
5. Substations and Pad-Mounted Equipment: 5 ohms.
6. Manhole Grounds: 10 ohms.

G. Excessive Ground Resistance: If resistance to ground exceeds specified values above, provide additional grounding electrodes to meet values above.

H. Provide a grounding system test in accordance with NFPA-99 for all patient care areas. Include test results in close-out documents. A Hampden Ground Integrity Tester Model MVO-1-PB or equivalent shall be used for grounding system test.

END OF SECTION

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.

B. Related Sections include the following:

1. Division 26 Section "Seismic Restraint For Electrical Systems" for requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported conduit systems and their contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products. For empty conduits, include weight of 5 type XHHW wires of maximum permissible size.

1.5 ACTION SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.

2. Nonmetallic slotted support systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.

2. Steel slotted channel systems. Include Product Data for components.

3. Nonmetallic slotted channel systems. Include Product Data for components.

4. Equipment supports.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Cooper B-Line, Inc.; a division of Cooper Industries.

b. ERICO International Corporation.

c. Thomas & Betts Corporation.

d. Unistrut; Tyco International, Ltd.

e. Hilti Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

3. Channel Dimensions: Selected for applicable load criteria.

4. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.

5. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.

6. Rated Strength: Selected to suit applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron in non-corrosive areas and fiberglass or stainless steel in corrosive areas.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized in non-corrosive areas and Stainless Steel (in corrosive areas.

F. Nonmetallic Slotted Support Systems – Corrosive Areas: Structural-grade, factory-formed, glass-fiber-resin channels, and angles with 9/16-inch-diameter holes at a maximum of 8 inches o.c., in at least 1 surface.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Allied Tube & Conduit.

b. Cooper B-Line, Inc.; a division of Cooper Industries.

c. Fabco Plastics Wholesale Limited.

d. Seasafe, Inc.

2. Channel Dimensions: Selected for applicable load criteria.

3. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.

4. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.

5. Rated Strength: Selected to suit applicable load criteria.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used. Approval from structural engineer shall be obtained prior to the use of power-actuated fasteners.

a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Hilti Inc.

2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.

3) MKT Fastening, LLC.

4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Cooper B-Line, Inc.; a division of Cooper Industries.

2) Empire Tool and Manufacturing Co., Inc.

3) Hilti Inc.

4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.

5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

6. Toggle Bolts: All-steel springhead type, Stainless Steel (in corrosive areas).

7. Hanger Rods: Galvanized threaded steel, Stainless Steel (in corrosive areas).

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter and except where support spacing requirements exceed NFPA 70 requirements.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for raceways as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps for conduits 1 ¼ inch and larger, single-bolt conduit clamps for conduits 1 inch inch and smaller and as approved by an agency acceptable to the authority having jurisdiction.

D. Corrosive Areas: Provide nonmetallic supports with stainless steel hardware in the following areas and as indicated on drawings.

1. Life support system (LSS) rooms.

2. Pool equipment rooms

3. Chemical storage rooms.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.

2. To New Concrete: Bolt to concrete inserts.

3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

4. To Existing Concrete: Expansion anchor fasteners.

5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.

6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts; Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69

7. To Light Steel: Sheet metal screws.

8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

E. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.

F. Obtain permission from Structural Engineer before drilling or cutting structural members.

G. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

H. Install surface mounted cabinets and panelboards with minimum of four anchors.

I. In wet and damp locations use channel supports to stand cabinets and panelboards one inch off wall.

3.3 LIGHTING FIXTURES

A. Lay-in Ceiling Lighting Fixtures Supports:

1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches from lighting fixture corners.

2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.

3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.

4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

B. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.

2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers and swivel aligners.

3. Verify stem/pendant/rod length.

4. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

C. Install channel supports across main grid runners or grid supports, securely tied down or anchored for fixtures and devices mounted in suspended ceiling systems so as not to cause tile to sag and so that fixture or device cannot be lifted, rotated, or displaced.

3.4 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.5 PAINTING

A. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Metal wireways and auxiliary gutters.
4. Surface raceways.
5. Boxes, enclosures, and cabinets.
6. Floor boxes
7. Recessed outlet boxes.
8. TV outlet boxes.

B. Related Sections include the following:

1. Division 7 Section “Through-Penetration Fire Stop Systems” for fire stopping materials and installation at penetration through walls, ceilings, and other fire-rated elements.
2. Division 26 Section "Seismic Restraint For Electrical Systems" for requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. FMC: Flexible metal conduit.

C. GRC: Galvanized rigid (steel) conduit.

D. IMC: Intermediate metal conduit.

E. LFMC: Liquidtight flexible metal conduit.

F. LFNC: Liquidtight flexible nonmetallic conduit.

G. NBR: Acrylonitrile-butadiene rubber.

H. RNC: Rigid nonmetallic conduit.

1.4 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification: Manufacturer's certification of seismic qualification according to ASCE 7. Submit ASCE 7 special seismic certification as required. Include method used to determine compliance with requirements.

1.6 PRE-INSTALLATION MEETING

A. Convene pre-installation meeting prior to installation of raceway components in casework and in walls shown to accept casework.

B. Attendees:

1. Contractor.

2. Electrical Subcontractor.

3. Plumbing Subcontractor.

4. Casework Installer.

5. Architect.

6. Owner (Owner's Representative).

C. Notify Architect seven days prior to meeting.

D. Prepare agenda and preside at meeting.

1. Review locations and mounting heights of devices and outlets shown. Compare to casework shop drawings.

2. Review routing of raceways through chases and cabinets.

3. Verify connection components of electrified components of casework.

E. Document final locations, connection points and mounting heights where at variance with plans. Distribute documentation to affected Subcontractors and to Architect.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AFC Cable Systems, Inc.

2. Allied Tube & Conduit; a Tyco International Ltd. Co.

3. O-Z/Gedney; a brand of EGS Electrical Group.

4. Robroy Industries.

5. Southwire Company.

6. Thomas & Betts Corporation.

B. Metal Conduit:

1. EMT: Comply with ANSI C80.3 and UL 797.

2. FMC: Comply with UL 1; zinc-coated steel or aluminum.

3. GRC: Comply with ANSI C80.1 and UL 6.

4. IMC: Comply with ANSI C80.6 and UL 1242.

5. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

6. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

a. Comply with NEMA RN 1.

b. Coating Thickness: 0.040 inch, minimum.

C. Metal Fittings:

1. Comply with NEMA FB 1 and UL 514B.

2. Listed and labeled for type of conduit, location, and use.

3. Hazardous (Classified) Locations: Comply with UL 1203.

4. Fittings for EMT:

a. Conduit Fittings for Indoor Wet Locations or Exterior: Steel insulated throat, compression, UL listed rain-tight.

b. Fittings for dry locations: Steel insulated throat, set-screw or compression type (Die-cast fittings will not be accepted).

5. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

6. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.

D. Joint Compound for IMC and GRC: Approved, as defined in applicable electrical code, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AFC Cable Systems, Inc.

2. Anamet Electrical, Inc.

3. Arnco Corporation.

4. Cantex Inc.

5. CertainTeed Corp.

6. Champion Fiberglass

7. Condux International, Inc.

8. Electri-Flex Company.

9. Kraloy.

10. Lamson & Sessions; Carlon Electrical Products.

11. Niedax-Kleinhuis USA, Inc.

12. RACO; a Hubbell company.

13. Thomas & Betts Corporation.

B. Nonmetallic Conduit:

1. Fiberglass:

a. Comply with NEMA TC 14.

b. Comply with UL 2515 for aboveground raceways.

c. Comply with UL 2420 for belowground raceways.

2. RNC: Type EPC-40-PVC, Type EPC-80-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

3. LFNC: Comply with UL 1660.

C. Nonmetallic Fittings:

1. Fittings, General: Listed and labeled for type of conduit, location, and use.

2. Fittings RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

a. Fittings for LFNC: Comply with UL 514B.

3. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal, complying with UL 870 and NEMA 250.

a. Indoor Dry and Clean Locations: Type 1.

b. Outdoor Locations: Type 3R.

c. Outdoor Locations subject to salt-laden air: Type 4X, 316 stainless steel.

d. Kitchen and wash-down areas: Type 4X, 316 stainless steel.

e. Pool and Water Equipment room with salt water, chlorine, or chemical storage: Type 4X, 316 stainless steel.

f. Other Wet or Damp Indoor Locations: Type 4.

B. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

C. Wireway Covers: Hinged type for Type 1 wireways, Flanged-and-gasketed type for Type 3R wireways.

D. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Mono-Systems, Inc.

b. Hubbell

c. Wiremold / Legrand.

B. Surface Metal Raceways: Steel, manufacturer's standard enamel finish in color selected by Architect.

1. Power – Single Channel: Wiremold G-3000.

2. Power/Communication – Two Channel with Divider: Wiremold G-4000.

C. Surface Metal Raceways: Aluminum with snap-on covers.

1. Power – Single Channel: Wiremold AL-3000.

2. Power/Communication – Two Channel with Divider: Wiremold AL-4000.

D. Tele-Power Poles:

1. Material: Aluminum with clear anodized finish.

2. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper Technologies Company; Cooper Crouse-Hinds.

2. Hoffman; a Pentair company.

3. Hubbell Incorporated; Killark Division.

4. O-Z/Gedney; a brand of EGS Electrical Group.

5. RACO; a Hubbell Company.

6. Robroy Industries.

7. Thomas & Betts Corporation.

8. Wiremold / Legrand.

B. General Requirements: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Galvanized Steel. Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Surface mount, NEMA FB 1, ferrous alloy, Type FD, with gasketed cover with stainless steel screws. Provide threaded hubs.

E. Weatherproof outlets shall utilize a use stainless steel or cadmium plated malleable iron box suitable for flush mounting.

F. Concrete Ceiling Boxes: 4 inch (102 mm) octagon, minimum depth of 3 inches (76 mm).

G. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

H. Paddle Fan Outlet Boxes: Nonadjustable, listed for attachment of paddle fan weighing 70 lb.

I. Device Box Dimensions: Minimum 4 inches square by 2-1/8 inches deep.

J. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

K. Gangable boxes are prohibited.

L. Sheet Metal Pull and Junction Boxes: NEMA OS 1.

M. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1,Type 3R, Type 4 with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

2.6 RECESSED OUTLET BOXES

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include and are not limited to, the following:

1. Arlington.

B. Duplex Receptacle Designation – Catalog # TVB505.

1. Two-Gang steel box w/white non-metallic trim plate.

2. Conduit knockouts for each gang.

C. Quad Receptacle Designation – Catalog # TVB505.

1. Two-Gang steel box w/white non-metallic trim plate.

2. Conduit knockouts for each gang.

2.7 TV OUTLET BOXES

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include and are not limited to, the following:

1. Arlington.

B. Duplex Receptacle Designation – Catalog # TVB505.

1. Two-Gang steel box w/white non-metallic trim plate.

2. Voltage separator between each gang.

3. Conduit knockouts for each gang.

C. Quad Receptacle Designation – Catalog # TVB507.

1. Three-Gang steel box w/white non-metallic trim plate.

2. Voltage separator between second and third gang compartment.

3. Conduit knockouts for each gang.

2.8 FLOOR BOXES

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include and are limited to, the following:

1. Wiremold / Legrand.

B. Single-Service Type – Non Poke-Thru

1. Manufacturer Series: RFBA Series.

2. Types of services: Power or Communications.

3. Shape: Rectangular box, round cover; rectangular cover for shallow depth box.

4. Number of Gangs: 2 Gang.

5. Box Construction / Material:

a. Within slab on grade: Metallic, epoxy coated (RFBA Series RFBA2C30OG).

b. Within raised slabs (10” or greater): Metallic (RFBA Series RFBA2C30).

1) For 2-hour fire-resistance rating in Building Code Type I construction, maintain minimum 5” concrete slab thickness below box.

c. Within raised slabs (9”): Metallic Shallow (RFBA Series RFBA2C25).

1) For 2-hour fire-resistance rating in Building Code Type I construction, maintain minimum 5” concrete slab thickness below box.

d. Within raised slabs (8”): Metallic Shallow (RFBA Series RFBA2R25).

1) For 2-hour fire-resistance rating in Building Code Type I construction, maintain minimum 5” concrete slab thickness below box.

6. Box Flange: Surface type, Evolution Series Round Cover; Rectangular RFB Cover for 8” raised slab.

7. Box Trim: Metallic, aluminum finish.

8. Accessories/ Cover: As required for installed devices.

9. Conduit Knockouts: (1)1" for Communications, (1)1" for Power.

10. Automatically controlled/switched receptacles shall be provided with manufacturer's, permanently marked "Controlled" receptacle designation. Provide additional unswitched receptacle per controlled receptacle.

11. Receptacles shall be 20-Amp rated and shall be manufacturer's listed receptacle(s).

C. Single-Service Type / Multi-Service Type – Non Poke-Thru (JBox, Furniture Feed).

1. Manufacturer Series: RFBA Series.

2. Types of services: Power or Communications for Single-Service, Power and Communications for Multi-Service.

3. Shape: Rectangular.

4. Number of Gangs: 2 Gang.

5. Box Construction / Material:

a. Within slab on grade: Metallic, epoxy coated (RFBA Series RFBA2R30OG).

b. Within raised slabs (9" or greater): Metallic (RFBA Series RFBA2R30).

1) For 2-hour fire-resistance rating in Building Code Type I construction, maintain minimum 5" concrete slab thickness below box.

6. Box Flange: Surface type, Evolution Series Round Cover; Rectangular RFB Cover for Furniture Feed.

7. Box Trim: Metallic, aluminum finish.

8. Accessories / Cover: As required for installed devices.

9. Conduit Knockouts: (1)1-1/4" for Communications, (1)1" for Power.

D. Multi-Service Type – Non Poke-Thru.

1. Manufacturer Series: Evolution and RFBA Series as indicated below per floor slab type.

2. Types of services: Power and Communications within same enclosure.

3. Shape: Rectangular box, round cover; rectangular cover for shallow depth box.

4. Number of Gangs: 4/5 Gang.

5. Box Construction / Material:

a. Within slab on grade: Metallic, epoxy coated (Evolution Series EFB45S-OG).

b. Within raised slabs (9" or greater): Metallic (RFBA Series RFBA4C30).

1) For 2-hour fire-resistance rating in Building Code Type I construction, maintain minimum 5" concrete slab thickness below box.

c. Within raised slabs requiring fire rating up to 3 hours: Metallic (Evolution Series EFB45S-FC12).

6. Box Flange: Surface type, Evolution Series Round Cover; Rectangular RFB Cover for 8" raised slab.

7. Box Trim: Metallic, aluminum finish.

8. Accessories/Cover: As required for installed devices.

9. Conduit Knockouts: (1)1-1/2" for Communications, (1)1" for Power.

10. Receptacles shall be 20-Amp rated and shall be manufacturer's listed receptacle(s).

E. Single-Service Type –Poke Thru – 4" (Quad Receptacle OR Communication).

1. Manufacturer Series: Evolution Series (4ATCP).

2. Types of services: Power or Communications.

3. Shape: Round.

4. Box Construction / Material:

a. Combination Metallic/Nonmetallic.

5. Box Flange: Surface type.

6. Box Trim: Metallic, aluminum finish.

7. Accessories/Cover: As required for installed devices.

8. Conduit Knockouts: (1) 1 ½" for Communications, (1) 3/4" for Power.

9. Fire rated to match floor rating.

10. Automatically controlled/switched receptacles shall be provided with manufacturer's, permanently marked "Controlled" receptacle designation. Provide additional unswitched receptacle per controlled receptacle.

11. Receptacles shall be 20-Amp rated and shall be manufacturer's listed receptacle(s).

F. Single-Service / Multi-Service Type –Poke Thru – 4" (JBox, Furniture Feed).

1. Manufacturer Series: Evolution Series (4AT).

2. Types of services: Power or Communications for Single-Service, Power and Communications for Multi-Service.

3. Shape: Round.

4. Box Construction / Material:

   a. Combination Metallic/Nonmetallic.

5. Box Flange: Surface type.

6. Box Trim: Metallic, aluminum finish.

7. Conduit Knockouts: (1) 1 ½" for Communications, (1) 3/4" for Power.

8. Accessories/Cover: As required for installed devices.

9. Fire rated to match floor rating.

G. Multi-Service Type –Poke Thru – 4" (Duplex Receptacle/Communication or Quad Receptacle).

1. Manufacturer Series: Evolution Series (4ATCP).

2. Types of services: Power and Communications within same enclosure.

3. Shape: Round.

4. Box Construction / Material:

   a. Combination Metallic/Nonmetallic.

5. Box Flange: Surface type.

6. Box Trim: Metallic, aluminum finish.

7. Accessories/Cover: As required for installed devices.

8. Fire rated to match floor rating.

9. Automatically controlled/switched receptacles shall be provided with manufacturer's, permanently marked "Controlled" receptacle designation. Provide additional unswitched receptacle per controlled receptacle.

10. Receptacles shall be 20-Amp rated and shall be manufacturer's listed receptacle(s).

H. Multi-Service Type –Poke Thru – 6" (Quad Receptacle/Communication).

1. Manufacturer Series: Evolution Series (6ATCP).
2. Types of services: Power and Communications within same enclosure.
3. Shape: Round.
4. Box Construction / Material:
   a. Combination Metallic/Nonmetallic.
5. Box Flange: Surface type.
6. Box Trim: Metallic, aluminum finish.
7. Accessories/Cover: As required for installed devices.
8. Fire rated to match floor rating.
9. Automatically controlled/switched receptacles shall be provided with manufacturer's, permanently marked "Controlled" receptacle designation. Provide additional unswitched receptacle per controlled receptacle.
10. Receptacles shall be 20-Amp rated and shall be manufacturer's listed receptacle(s).

I. Weatherproof Type – (Duplex or Quad Receptacle or Communication Only).

1. Manufacturer Series: Outdoor Weatherproof Series (XB814).
2. Types of services: Power **OR** Communications in each enclosure. Provide separate enclosure for each service.
3. Shape: Rectangular.
4. Sizes of services: As noted on drawings.
5. Box Construction / Material: Non-Metallic, UV Rated, NEMA 6P
6. Box Flange & Trim: Flush with grade
7. Cover Weight Loading: minimum 5,000 lbs.
8. Accessories: As required for installed devices.
9. Duplex receptacles shall be 20-Amp rated and shall be manufacturer's listed receptacle(s).

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit: GRC or IMC.

2. Concealed Conduit, Aboveground: GRC, IMC, EMT.

3. Underground Conduit:

a. Outside Building Foundation: RNC, Type EPC-40-PVC,.

b. Under Slab on Grade: Use RNC, Type EPC-40-PVC.

c. Within Hydrostatic Slab on Grade: RNC, Type EPC-40-PVC, in concrete slab, above water proofing barrier(s).

4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.

5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.

2. Exposed and Subject to Severe Physical Damage: GRC or IMC to below switch height. Raceway locations include the following:

a. Loading docks.

b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.

3. Exposed Wet or Damp Locations: Use GRC or IMC between finish grade and 96 inches (2.5 m) above finish grade. Use EMT above 96 inches (2.5 m) with rain-tight compression fittings.

4. Concealed above Ceilings, elevated underfloor, and in Interior Walls and Partitions: EMT.

5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.

6. Concealed in Concrete Walls or Slab: RNC, Type EPC-40-PVC.

7. Connections to Lighting Fixtures in Accessible Ceilings: FMC – max 72 inches (1.8 m) in length.

8. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: EMT.

9. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: EMT.

10. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: EMT.

11. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 3R in damp or wet locations.

C. Minimum Raceway Size:

1. Minimum conduit size shall be 3/4-inch trade size except for switch legs and control circuits may be 1/2-inch.

2. Minimum FMC size shall be 1/2-inch except flexible connections to lighting fixtures may be 3/8-inch, not to exceed 6 feet in length

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.

2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.

3.2 EXPANSION FITTINGS – BUILDING EXPANSION JOINTS

A. Provide appropriate type of building expansion fittings as identified in this specification as required for each type of raceway.

B. For quantity and location of **ALL** building expansion joints refer to Architectural and Structural drawings. Exact quantity and locations of expansion fittings may or may not be shown on the electrical plans and does not relieve the responsibility of the contractor to coordinate with other disciplines for building expansion joints. Change orders will not be allowed for missed expansion joints by contractor.

3.3 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Do not fasten conduits onto the bottom side of a metal deck roof.

C. Keep raceways at least 12 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

D. Conduit routing shown on drawings indicate approximate locations unless dimensioned. Route as required to complete wiring system.

E. Complete raceway installation before starting conductor installation.

F. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems" for hangers and supports.

G. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

I. Install 4 to 6 foot flexible steel conduit drops from an independent junction box mounted above ceiling and accessible from below ceiling to recessed ceiling mounted equipment. Allow for positioning of equipment to tile increments.

J. Flexible conduit , including MC cable, shall not be run from light fixture to light fixture.

K. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.

L. Conceal conduit within finished walls, above ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

1. Conduits for interior building branch circuits shall not be installed below floor slab on grade or within concrete floor slabs except as explicitly required for equipment specific connections

2. RNC conduit shall not be used in interior spaces. Conduit shall not be run below or within floor slabs for branch circuits within interior spaces, unless otherwise noted on drawings for certain spaces. Where RNC conduit is run below floor slabs for feeder conduits and conduit is stubbed above slab, EMT or galvanized rigid steel conduit shall be provided for conduit above floor slab. RNC conduit for feeders for emergency system shall be EPC-80-PVC. Where it is impossible to run conduit for

branch circuits overhead to equipment and receptacles, conduit shall be run below slabs on grade or run within concrete slab, if not on grade, and conduit shall be PVC-Coated Rigid Steel.

M. Support conduit within 12 inches of enclosures to which attached.

N. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum10-foot intervals.

2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.

3. Where the first outlet box or device is more than 18" above finished floor transition from PVC to EMT, IMC, or rigid steel conduit before rising above the floor.

4.

O. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or GRC for raceways.

2. Use conduit bushings or insulated fitting at conduit ends not terminated in hubs or to an enclosure.

P. Underground Conduit Bends:

1. Conduit Bends: Use PVC coated metal conduit for bends greater than 45° in conduits 1-1/2 inches trade size and larger, except where not allowed by the serving utility company.

Q. Use EMT conduit for all isolated circuit conductors. Under no circumstances shall wiring pulling compounds be used when pulling the wire for isolated circuits.

R. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

S. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

T. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

U. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

V. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

W. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

X. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

Y. Surface Raceways:

1. Install surface raceway with a minimum 2-inch radius control at bend points.

2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

Z. Raceways for Optical Fiber and Communications Cable: Install raceways, rigid, metallic and nonmetallic, as follows:

1. 3/4 inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet.

2. 1 inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.

3. Any section of conduit longer than 150 feet or containing more than two (2) 90-degree bends shall have pull boxes. These boxes are not shown on drawings.

4. Communications conduits shall be separated from power conduits. Coordinate with Communications, Specialty Contractors, and Building Industry Consulting Service International (BICSI) recommendations.

AA. Install raceway sealing fittings/compound at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.

2. Areas where conduits are in water such as fountains and pools.

3. Where an underground raceway enters a building or structure.

4. Any exterior or wet areas where conduits stub up above ground with cables exiting.

5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.

6. Where otherwise required by NFPA 70.

BB. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

CC. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RNC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.

2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.

b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.

c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.

d. Attics: 135 deg F temperature change.

3. Install expansion fittings at all locations where conduits cross building or structure expansion joints.

4. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

DD. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.

2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

EE. Conduit Routing:

1. Arrange conduit to maintain headroom and present neat appearance.

2. Route exposed conduit parallel with and perpendicular to walls and other building architectural and structural elements.

3. Route conduits above accessible ceilings to clear access openings.

4. Maintain adequate clearance between conduit and piping of other trades.

5. Maintain 12 inches clearance between conduit and surfaces with temperatures exceeding 104 deg F.

FF. Cut conduit square using saw or pipe cutter; de-burr cut ends.

GG. Use conduit bodies to make sharp changes in direction, as around beams.

HH. Provide suitable fittings to accommodate expansion and deflection where conduit crosses control and seismic expansion joints.

II. Use suitable caps to protect installed conduit against entrance of dirt and moisture.

JJ. Termination of Conduit Stubs:

1. Underground and Flush with Finish Floor: Use coupling and threaded plug.

2. Above Floor: Use conduit bushing.

3. Low Voltage Systems (comm, security, AV, etc.): Use conduit bushing.

KK. Make conduit penetrations of exterior concrete or masonry walls below grade, and of floor slabs on fill below grade, watertight.

3.4 RECESSED OUTLET INSTALLATION

A. Provide wiring devices per specification “Wiring Devices.”

3.5 TV OUTLET INSTALLATION

A. Provide wiring devices per specification “Wiring Devices.”

B. Provide (1) ½” Conduit from low voltage gang to accessible ceiling.

C. Coordinate mounting with TV mount / location prior to installation.

3.6 FLOOR BOX INSTALLATION

A. General Requirements.

1. Set floor boxes level and flush with finished floor surface. Use fire rated floor boxes where penetrating slab or where required to maintain floor fire rating.

2. Maintain floor slab fire rating at each floor box.

3. Floor boxes shall be located as dimensioned on Architect's or Interior Designer's plans, unless noted otherwise.

4. Floor boxes shall be oriented aligned with walls in room.

5. Provide all accessories required for a complete installation with the device types indicated.

6. Provide UL listed weatherproof floor boxes in all outdoor locations, and all locations subject to rain water.

7. All weatherproof and outdoor floor boxes shall have drainage provisions per manufacturers recommendations.

8. Properly wire controlled receptacles to room occupancy/vacancy controllers

9. Field coordinate core drill location for all poke-thru floor boxes to avoid conflict with structural elements. Obtain structural approval for location prior to core drilling. Xray slab if required by structural prior to core drilling.

B. Raceway requirements:

1. Single-Service Type (non poke-thru):

   a. Minimum 1" conduit or code required size for power, from box to above accessible ceiling, unless noted otherwise.

   b. (1) 1" conduit for future from other side of box stubbed above accessible ceiling, on the same floor, unless noted otherwise.

2. Single-Service Type / Multi-Service Type – Non-Poke-Thru (JBox, Furniture Feed).

   a. Minimum 3/4" conduit or code required size for power, from box to above accessible ceiling, unless noted otherwise.

   b. (1) 1-1/4" conduit for communication/low voltage stubbed above accessible ceiling, on the same floor, unless noted otherwise.

   c. Furniture Feed – Provide connection to powered furniture system as required to be fully functional.

3. Multi-Service Type (non-poke-thru):

a. Minimum 1" conduit or code required size for power, from box to above accessible ceiling, unless noted otherwise.

b. (2) 1-1/4" conduit for communication/low voltage stubbed above accessible ceiling, on the same floor, unless noted otherwise.

4. Poke-Thru Type (Single and/or Multi Service):

a. Minimum 3/4" conduit or code required size for power, unless noted otherwise.

b. (1) 1-1/2" conduit for communication/low voltage stubbed above accessible ceiling, on the same floor, unless noted otherwise.

c. For single-service type provide conduits as noted above for respective service.

5. Single-Service Type / Multi-Service Type – Poke-Thru (JBox, Furniture Feed).

a. Minimum 3/4" conduit or code required size for power, from box to above accessible ceiling, unless noted otherwise.

b. (1) 1-1/2" conduit for communication/low voltage stubbed above accessible ceiling, on the same floor, unless noted otherwise.

c. Furniture Feed – Provide connection to powered furniture system as required to be fully functional.

6. Ballroom Type:

a. Minimum of (3) 1" conduits or code required size for power, from box to above ceiling accessible ceiling, unless noted otherwise.

b. (2) 1-1/2" conduits for communication/low voltage stubbed above accessible ceiling, on the same floor, unless noted otherwise.

7. Convention Center Type:

a. Minimum of (2) 2" conduits or code required size for power, from box to above ceiling accessible ceiling, unless noted otherwise.

b. (2) 2" conduits for communication/low voltage stubbed above accessible ceiling, on the same floor, unless noted otherwise.

c. Refer to drawings for additional requirements, may or may not include plumbing drawings

8. Weatherproof Type:

a. Power Type: Minimum 1" conduit or code required size for power, unless noted otherwise.

b. Communication/ Low Voltage Type: Minimum 1-1/2" conduit for communication/low voltage, unless noted otherwise.

3.7 OUTLET BOX INSTALLATION

A. Location of outlets and equipment as shown on drawings is approximate, and exact location shall be verified and shall be determined by:

1. Construction or code requirements.

2. Conflict with equipment of other trades.

3. Equipment manufacturer's drawings.

4. As dimensioned on interior or architectural elevations/plans as long as in compliance with all applicable codes.

B. All outlet boxes shall be mounted flush with wall surface unless noted otherwise.

C. Weatherproof outlet boxes specifically noted for surface mounting shall utilize a cast metal box complete with threaded conduit ends for surface outlets.

D. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

E. Use plaster rings for all concealed work except for masonry boxes; depth of rings as required to reach finished surface.

F. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

G. Use masonry boxes with square corners in tile, marble, brick, or concrete block.

H. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits or from ceiling support wires.

I. Orient boxes to accommodate wiring devices oriented as specified in Division 26 Section "Wiring Devices".

J. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches (150 mm) from ceiling access panel or from removable recessed luminaire.

K. Conflict with millwork, tack boards, etc. Coordinate mounting heights and location of outlets mounted above counters, benches, and backsplashes. Contractor shall review architectural elevations and millwork drawings before roughing-in boxes and conduit. Any conflicts shall be noted and addressed by an RFI requesting direction as to resolution. Adjusting box locations due to such conflicts shall be at no additional compensation.

L. Minor modification in the location of outlets and equipment is considered incidental up to a distance of 10 feet with no additional compensation, providing necessary instructions are given prior to roughing in of outlet.

M. Electrical outlet boxes may be installed in vertical fire resistive assemblies classified as fire/smoke and smoke partitions without affecting the fire classification, provided such openings do not exceed 16 square inches and they are located per applicable U.L. assembly. All clearances between such outlet boxes and the gypsum board must be completely filled with joint compound or other approved materials. The wall must be built around outlets of a larger size so as to not interfere with the integrity of the wall rating. The aggregate surface area of the boxes shall not exceed 100 square inches per 100 square feet. Boxes located on opposite sides of walls or partitions shall be separated by a horizontal distance of 24 inches or by providing listed putty pads around both boxes. The metallic outlet or switch boxes shall be securely fastened to the studs and the opening in the wallboard facing shall be cut so that the clearance between the box and the wallboard does not exceed 1/8 inch (3mm).

N. Do not install boxes back-to-back or through wall. Offset outlet boxes on opposite sides of wall a minimum of 12 inches or on opposite sides of stud in partition walls. Where back-to-back boxes cannot be avoided, provide gypsum board between boxes.

O. Where more than two switches or devices are located at one point, use ganged boxes and covers, unless devices do not allow for ganging or manufacturer recommends otherwise. Provide permanently installed barriers between adjacent switches as required to meet regulatory requirements.

P. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

Q. Install emergency switches which occur adjacent to normal light switches in separate boxes to maintain system's isolation in accordance with NFPA 70 required separation

3.8 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.9 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.10 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 26 05 44 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction of poured concrete walls and floors.

2. Sleeve-seal systems.

3. Sleeve-seal fittings.

4. Grout.

5. Silicone sealants.

B. Related Requirements:

1. Division 07 Section "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Advance Products & Systems, Inc.

b. CALPICO, Inc.

c. Metraflex Company (The).

d. GPT Industries – (Link-Seal)

2.2 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.

2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.

2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.

b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.3 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Sealing Elements: EPDM or Nitrile (Buna N**)** rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

2. Pressure Plates: Glass Reinforced Plastic or Reinforced Nylon Polymer or Stainless Steel.

3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

4. Positive hydrostatic seal rated at 20 psig or greater.

2.4 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.6 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section “Joint Sealants."

b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.

5. Install sleeves for above grade floor penetrations. Extend sleeves installed in floors 4 inches above finished floor level. Install sleeves during erection of floors.

D. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

E. Aboveground, Exterior-Wall Penetrations: Seal penetrations using **steel** pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

F. Underground, Exterior-Wall and Floor Penetrations: Install pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION

SECTION 26 05 49 - SEISMIC RESTRAINT FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Related Requirements:

1. Division 26 Section “Hangers and Supports for Electrical Systems” for commonly used electrical supports and installation requirements.

1.3 DEFINITIONS

A. ASCE: American Society of Civil Engineers.

B. IBC: International Building Code.

C. CBC: California Building Code.

D. Life Safety / Emergency Systems:

1. All systems involved with fire protection, including sprinkler piping, fire pumps, jockey pumps, fire pump control panels, service water supply piping, water tanks, fire dampers and smoke exhaust.

2. All systems involved with production and distribution of and utilization equipment connected to emergency power supply, including all generators, transfer switches, transformers and all circuits to fire protection, smoke evacuation and/or emergency lighting systems.

3. All medical and life support systems.

4. Fresh air and relief systems on emergency smoke control sequence, including air handlers, conduit, duct, dampers, fans, etc.

E. [HCAi: Health Care Access and Information for the State of California.]

1.4 PERFORMANCE REQUIREMENTS

A. Equipment and Distribution Components: Design supports, attachments, and restraints according to CBC and ASCE 7 as Delegated-Design.

B. Equipment and Distribution Components: Select support, attachment, and restraint details complying with requirements of CBC and ASCE 7 for equipment and distribution components from one of the following HCAi Pre-Approvals:

1. Cooper B-Line (OPA-0114).

2. SMACNA (OPA-0010).

3. Mason Industries (OPA-0349).

4. ISAT (OPA-0485).

C. Use seismic design values shown on structural drawings.

D. Treat components that are part of patient life support/life safety /emergency systems as having Component Importance Factor = 1.5. Treat other components as having Component Importance Factor = 1.5 if so scheduled on the drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Delegated-Design Submittal: For seismic restraint details governed by performance requirements, include analysis data signed and sealed by a professional engineer responsible for their preparation who is qualified for such work in the place of the project.

1. Design Calculations: Calculate loading due to equipment weight, operation, and seismic forces required to select seismic restraints.

a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors.

2. Include materials and dimensions and identify hardware, including attachment and anchorage devices, for equipment and for manufactured and field fabricated supports.

3. Seismic Restraint Details:

a. Design Analysis: Support selection and arrangement of seismic restraints.

b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Identify components, Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices, where applicable.

c. Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

B. Coordination Drawings: Show proposed locations of supports and restraints for distribution system components.

1. Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.

2. Include details selected from HCAi Pre-Approvals, and reference proposed locations to specific details selected.

3. Reference proposed locations of supports and restraints to Delegated-Design Submittal details.

1.6 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel".

C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage[pre approved by ICC-ES, or preapproved by another agency acceptable to authorities having jurisdiction][pre-approval OPA number from HCAi] showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a[qualified professional engineer][State of California licensed structural engineer].

PART 2 - PRODUCTS

2.1 SEISMIC-RESTRAINT DEVICES

A. Basis-of-Design Product: Subject to compliance with requirements, provide products of Mason Industries or a comparable product by one of the following:

1. Cooper B-Line, Inc.; a division of Cooper Industries.

2. Hilti Inc.

3. Loos & Co.; Seismic Earthquake Division.

4. ISAT.

5. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components:

1. Components used in HCAi Pre-Approval details: Use products according to HCAi Pre-Approval details selected for this project.

2. Components used in Delegated-Design details: Rated strengths, features, and application requirements shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

2.2 FACTORY FINISHES

A. Finish: Manufacturer's standard paint or galvanized.

1. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive seismic restraint devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing in of reinforcement and cast-in-place anchors to verify actual location before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATION

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze members with clamps according to HCAi Pre-Approval details.

3.3 SEISMIC RESTRAINT DEVICE INSTALLATION

A. Install seismic restraints for equipment according to details on Structural drawings.

B. Install seismic restraint devices for distribution components according t Delegated-Design and HCAi Pre-Approval details.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 FIELD QUALITY CONTROL

A. Tests and Inspections: Test and inspect to meet regulatory requirements.

END OF SECTION

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.3 QUALITY ASSURANCE

A. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

B. Comply with ANSI Z535.4 for safety signs and labels.

C. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.4 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound or tubing type, with circuit identification legend machine printed by thermal transfer or equivalent process.

1. Locations: Each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection.

2. Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings including neutral conductor.

3. Control Circuits: Control wire number indicated on schematic and interconnection diagrams on shop drawings.

2.2 FLOOR MARKING TAPE

A. 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.3 UNDERGROUND-LINE WARNING TAPE

A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.

1. Not less than 6 inches wide by 4 mils thick.

2. Embedded continuous metallic strip or core.

3. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.

4. Printing on tape shall be permanent and shall not be damaged by burial operations.

5. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.

2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.

3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

2.4 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 1/2 inch.

C. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2.5 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.

2. Punched or drilled for mechanical fasteners.

3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 1/2 inch.

2.7 CABLE TIES

A. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.

2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.

3. Temperature Range: Minus 40 to plus 185 deg F.

4. Color: Black.

B. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.

1. Minimum Width: 3/16 inch.

2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.

3. UL 94 Flame Rating: 94V-0.

4. Temperature Range: Minus 50 to plus 284 deg F.

5. Color: Black.

2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping stainless steel screws, except contact type permanent commercial grade adhesive providing a permanent bond shall be used where screws cannot or should not penetrate substrate.

C. Two-sided tape and dynamo type adhesives are not acceptable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. Cable Ties: For attaching tags. Use as listed below:

1. Indoors and Outdoors: UV-stabilized nylon.

2. In Spaces Handling Environmental Air: Plenum rated.

G. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 12 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

H. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION REQUIREMENTS

A. Colors for Metal Clad Cable and Accessible Raceways Carrying Circuits at 600 V or Less:

1. Paint all junction boxes, junction box covers, and conduit fittings using color code legend.

2. Legend:

a. Emergency Power Supply (EPS) – Purple

b. Emergency System Life Safety Branch – Yellow

c. Emergency System Critical Branch – Orange

d. Equipment System Branch – Green

B. Colors for Raceways for Low Voltage Systems:

1. Paint all junction boxes, junction box covers, and conduit fittings using color code legend.

2. Legend:

a. Fire Alarm System – Red

b. CCTV System – Brown

c. CATV System – Black

d. Access Control System – Light Blue

e. Telecommunications System (Voice/Data) - White

f. Nurse Call Systems – Pink]

g. Doctor's Dictation/Physiological Monitoring Systems – White

3. If existing color coding is different than indicated above, match existing color coding.

C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in panelboards, switchboards, switchgear, vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors and neutral and ground conductors.

a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.

b. Colors for 208Y/120V Circuits:

1) Phase A: Black.

2) Phase B: Red.

3) Phase C: Blue.

4) Neutral: White.

5) Ground: Green.

6) Isolated Ground: Green/Yellow Tracer.

c. Colors for 480Y/277V Circuits:

1) Phase A: Brown.

2) Phase B: Orange.

3) Phase C: Yellow.

4) Neutral: Gray.

5) Ground: Green.

6) Isolated Ground: Green/Yellow Tracer.

d. If existing color coding is different than indicated above, match existing color coding.

2. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or

taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

D. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil 4-inch-wide black stripes on 10-inch centers over orange background that extends full length of raceway or duct and is 12 inches wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch-high black letters on 20-inch centers. Stop stripes at legends. Apply to the following finished surfaces:

1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.

2. Wall surfaces directly external to raceways concealed within wall.

3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

E. Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: Self-adhesive vinyl labels. Install labels at 10-foot maximum intervals.

F. Power-Circuit Conductor Identification, more than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic plastic tag holder with adhesive-backed phase tags, and a separate tag with the circuit designation.

G. Install instructional sign in the main electrical room including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

H. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.

I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

J. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Install underground-line warning tape for both direct-buried cables and cables in raceway.

K. At each junction box, the covers on junction boxes and pull boxes in areas that are not to be painted shall be marked with "Indelible Markers" to indicate the panel and circuit number(s) of conductors in the box. In areas where exposed conduit and junction boxes are to be painted, indicate circuit number(s) of conductors in the box on the inside cover of the box.

L. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.

1. Comply with 29 CFR 1910.145.

2. Identify system voltage with black letters on an orange background.

3. Apply to exterior of door, cover, or other access.

4. For equipment with multiple power or control sources, apply to door or cover of equipment.

M. Stored Energy Devices/Equipment (UPSs and Inverters)

1. Provide Warning sign(s) on the door(s) leading into spaces containing energy storage devices to alert first responders there may be energized equipment inside. Provide a sign clearly indicating the disconnect to the output of the energy storage device, if exists.

N. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with design documents. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

a. Indoor Equipment: Engraved, laminated acrylic, or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high and where three lines of text are required, use 3 inches

b. Outdoor Equipment: Engraved, laminated acrylic, or melamine label.

c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

a. Panelboards.

b. Enclosures and electrical cabinets.

c. Access doors and panels for concealed electrical items.

d. Disconnects

e. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.

f. Emergency system boxes and enclosures.

g. Motor-control centers.

h. Enclosed switches.

i. Enclosed circuit breakers.

j. Enclosed controllers.

k. Variable-speed controllers.

l. Power transfer equipment.

m. Contactors.

n. UPS equipment.

o. Lighting Control Equipment

p. Power Inverters

O. Engraved laminate signs for equipment identification shall have white lettering in a colored field as indicated below for the following systems:

1. Normal Power - Black

2. EPS System - Purple

3. Emergency System Life Safety Branch - Yellow

4. Emergency System Critical Branch - Orange

5. Emergency System Equipment Branch - Green

6. Fire Alarm System - Red

7. Nurse Call Systems - Blue

8. If existing color coding is different than indicated above, match existing color coding.

P. Equipment connected to the Essential Electrical System (panels, transfer switches, disconnects, etc.) shall be labeled as per branch, i.e.: "PANEL XXX-LIFE SAFETY BRANCH"; "PANEL XXX-CRITICAL BRANCH"; "PANEL XXX EQUIPMENT BRANCH". Voltage shall also be indicated.

Q. Panelboard identification shall indicate panelboard designation, voltage and where fed from, i.e., "PANEL 1LA – 208Y/120V, 3Ø, 4W"

R. FE

S. Provide energy storage warning sign(s) on the door(s) leading into the spaces containing energy storage devices to alert first responders there may be energized equipment.

1. Provide a warning sign for the first responders to easily identify the disconnect to the output of the energy storage devices.

T. Panelboards located in storage rooms shall have floor space per NEC-110 permanently marked and shall be identified as "Electrical Access - Not For Storage."

U. Identify each conductor with its circuit number or other designation indicated on Drawings.

V. Identify neutrals with its associated circuit number(s).

W. Install conductor markers at all new connections and terminations and existing connections and terminations, modified or altered.

3.3 ENGRAVED COVER PLATES

A. All cover plates for control stations controlling remote equipment shall be engraved to identify the device being controlled.

B. Engraved cover plates shall be supplied and installed on all switches serving lobbies, corridors, and other public locations and shall indicate load controlled.

C. Wiring device cover plates shall be factory engraved to indicate panel designation and circuit number (i.e.“1HLA-7”). Letter height shall be ¼”, recessed and colored:

a. Black for normal power

b. White for emergency power (on red faceplate)

c. Blue for UPS power

D. For receptacles other than 20A, 120V, engraving shall include receptacle voltage, phase, and amperage at top of receptacle and panel designation and circuit numbers at bottom of receptacles.

E. Adhesive labels and nameplates are not acceptable.

3.4 COVER PLATES

A. All wiring device cover plates shall have panel designation and circuit number (i.e."1HLA-7") serving device clearly marked on the front of each faceplate to match existing circuit labelling.

3.5 PANELBOARD CIRCUIT DIRECTORIES

A. Install in each panelboard a typewritten directory accurately indicating rooms and equipment being served. Verify actual room names and numbers to be used. Also, provide a copy of typewritten panelboard directories in Owner's close-out manuals.

B. Where new circuits are added to existing panelboards or existing circuits deleted, provide new typewritten panelboard circuit directory with added circuits identified and deleted circuits indicated as 'spare'. Circuit identification shall indicate room and equipment being served.

3.6 ENCLOSED MOTOR CONTROLLERS

A. Provide neatly typed label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor and voltage/phase rating.

END OF SECTION

SECTION 26 05 73 - SYSTEM STUDIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes computer-based, electrical system studies, including:

1. Fault current study.
2. Protective device coordination study.
3. Arc flash hazard study.

B. Protective devices shall be set based on results of the protective device coordination study.

C. Provide a selectively and fully coordinated system in accordance with NFPA 70, NFPA 99, state and local requirements. Provide overcurrent devices with characteristics that coordinate with upstream and downstream overcurrent devices.

D. Overcurrent devices shall be selected to achieve selective coordination down to a 0.1 second level. There shall be no overlap between devices to this level.

1.3 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Other Action Submittals: Submittals shall be in digital form, except as noted.

1. Study input data, including completed computer program input data sheets, and single line diagrams of existing and new system equipment.
2. Study and Equipment Evaluation Reports.
3. SKM PowerTools input and output files used in developing system studies.
4. Provide a tabulation of settings for all overcurrent device adjustable trips, time delays, relays, and ground fault coordination for all overcurrent devices in the system
5. Sample Arc flash hazard warning label.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For systems study specialist.

B. Product Certificates: For system studies computer software programs, certifying compliance with IEEE 399.

1.5 CLOSEOUT SUBMITTALS

A. Provide final approved system studies in electronic PDF form on USB Drive.

B. Provide SKM electronic data file of approved system studies.

C. Completed Arc flash hazard warning labels (1 set of labels installed by contractor and printout of labels in report for filing).

D. Service Fault Current Calculations

1. Include documentation from utility company for source available fault current and at what point in the system the fault current applies.

1.6 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. System Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Professional engineer, licensed in the state where Project is located, shall be responsible for the studies. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

E. Comply with IEEE 1584 for arc flash hazard study.

F. Comply with NFPA-70E for arc flash hazard personal protective equipment (PPE) and label requirements.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Subject to compliance with requirements, provide products by SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

1. Required Features:

a. Arcing faults.
b. Simultaneous faults.
c. Explicit negative sequence.
d. Mutual coupling in zero sequence.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance.

1. Fault current study and coordination study shall be completed in conjunction with the submittal of electrical equipment including, but not limited to, switchgear, switchboards, distribution panelboards, panelboards, motor control centers, circuit breakers, disconnect switches, transfer switches, variable frequency drives and other equipment required to have withstand or interrupting capability. Ordering of equipment prior to approval of fault study shall be at Contractor’s risk. Any modifications to equipment ratings required as a result of the approved fault current study shall be provided by Contractor at no cost to the owner.
2. Proceed with coordination study only after relevant equipment submittals have been assembled. The coordination study shall be done in conjunction with the panelboard and switchboard submittal and submitted together for review. Ordering of equipment prior to approval of the coordination study shall be at Contractor’s

risk. Any modifications to equipment required as a result of the approval coordination study shall be provided by Contractor at no cost to the owner.

3. Proceed with arc flash hazard study only after coordination study protective device settings have been approved.

3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support system studies:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Impedance of utility service entrance.
3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:

    a. Circuit-breaker and fuse-current ratings and types.
    b. Relays and associated power and current transformer ratings and ratios.
    c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
    d. Generator kilovolt amperes, size, voltage, and source impedance.
    e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
    f. Busway ampacity and impedance.
    g. Motor horsepower and code letter designation according to NEMA MG 1.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:

    a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
    c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
    d. Generator thermal-damage curve.
    e. Ratings, types, and settings of utility company's overcurrent protective devices.
    f. Special overcurrent protective device settings or types stipulated by utility company.
    g. Time-current-characteristic curves of devices.
    h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.

i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
j. Panelboards, switchboards, motor-control center, variable frequency drive, disconnect switch ampacity, and interrupting rating in amperes rms symmetrical.
k. Transfer switch ampacity and withstand rating.

3.3 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the electrical system components, including but not limited to the following:

1. Switchgear and switchboard bus.
2. Medium-voltage equipment.
3. Motor-control center.
4. Distribution panelboard.
5. Branch circuit panelboard.
6. Variable frequency drive.
7. Disconnect switch.
8. Transfer switch.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 242.

1. Transformers, as applicable:

a. ANSI C57.12.10.
b. ANSI C57.12.22.
c. ANSI C57.12.40.
d. IEEE C57.12.00.
e. IEEE C57.96.

2. Medium-Voltage Circuit Breakers: IEEE C37.010.
3. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
4. Low-Voltage Fuses: IEEE C37.46.

E. Study Report:

1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.

F. Equipment Evaluation Report:

1. For 600-V overcurrent protective devices and equipment, ensure that interrupting ratings and withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.

1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
2. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE 242 recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a. Inrush current when first energized.
b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.

E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

F. Selective Coordination Settings: Select overcurrent protective device setting to achieve selective coordination for those systems as required by NFPA 70, state and local requirements.

G. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:

a. Device tag.
b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
d. Fuse-current rating and type.
e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

a. Device tag.
b. Voltage and current ratio for curves.
c. Three-phase and single-phase damage points for each transformer.
d. No damage, melting, and clearing curves for fuses.
e. Cable damage curves.
f. Transformer inrush points.
g. Generator damage curve, line-to-ground decrement curve and three phase decrement curve.
h. Maximum fault-current cutoff point.

H. Completed data sheets for setting of overcurrent protective devices.

3.5 ARC FLASH HAZARD STUDY

A. Perform an arc flash hazard study using approved computer software program.

B. The arc flash hazard study shall include all significant locations in the electrical distribution system when work could be performed on energized parts. Locations shall include, but not be limited to, the following:

1. Switchgear.
2. Switchboard.
3. Motor control center.
4. Panelboard.

5. Enclosed Circuit breaker.
6. Disconnect Switch.
7. Variable frequency drive.
8. Transfer Switch.
9. Large Inverters/UPS's

C. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm2.

D. The fault current calculations and the clearing times of the phase overcurrent devices shall be retrieved from the fault current and coordination study model. Ground overcurrent relays shall not be taken into consideration when determining the clearing time when performing incident energy calculations.

E. The fault current calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum contributions of fault current magnitude for all normal and emergency operating conditions. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

F. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:

1. Fault contribution from induction motors shall not be considered beyond 3-5 cycles.
2. Fault contribution from synchronous motors and generators shall be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).

G. For each equipment location with a main overcurrent protective device, calculations for incident energy and flash protection boundary shall include both the line and bus side of the main device.

H. When performing incident energy calculations on the line side of a main device (as required above), the line side and bus side contributions must be included in the fault calculation.

I. Arc flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584.

J. Calculate the following for each equipment location for line side and bus side, as appropriate:

1. Flash hazard protection boundary.

2. Limited approach boundary.
3. Restricted boundary.
4. Prohibited boundary.
5. Incident energy level.
6. Required personal protective equipment class.
7. Type of fire rated clothing.

K. Study Report

1. Study report shall include pertinent data, procedures, assumptions, results, and recommendation for arc flash hazard reduction.
2. Provide an arc flash hazard evaluation summary listing the following:

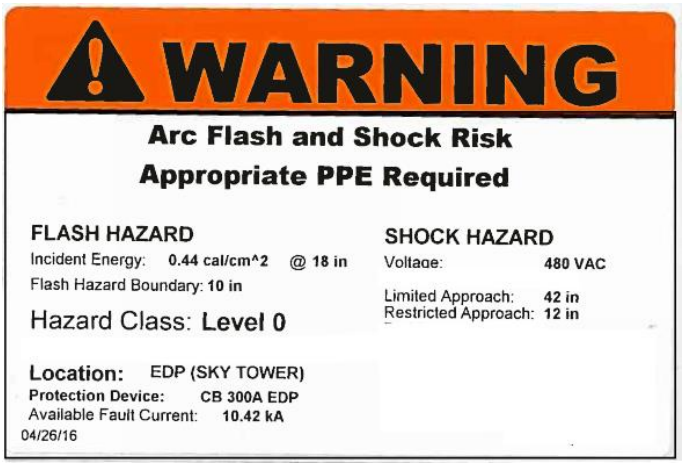
a. Bus name.
b. Upstream protective device name, type and settings.
c. Bus line to line voltage.
d. Bus bolted fault.
e. Protective device bolted fault current.
f. Arcing fault current.
g. Protective device trip/delay time.
h. Breaker opening time.
i. Solidly grounded column.
j. Equipment type.
k. Gap.
l. Arc flash boundary.
m. Working distance.
n. Incident energy.
o. Required protective fire rated clothing type and class.

L. Arc Flash Hazard Label

1. Provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each equipment location analyzed.
2. All labels shall be based on recommended overcurrent device settings and shall be provided after the results of the study have been approved.
3. Each label shall include the following information, at a minimum:

a. Equipment designation.
b. Nominal voltage.
c. Flash hazard protection boundary.
d. Hazard risk category.
e. Incident energy.
f. Limited approach boundary.
g. Restricted boundary.
h. Prohibited boundary.
i. Date of issue.

4. Label Example



M. Contractor shall field install arc flash hazard labels.

3.6 ARC-FLASH MITIGATION – ENERGY REDUCING MAINTENANCE SWITCH.

A. Provide maintenance mode setting for all electrical gear with breaker frames 1200 amp and larger to reduce arc-flash energy by reducing the time delay to no intentional delay in accordance with the NEC.

1. Include calculations for on / off positions Energy Reducing Maintenance Switch.

a. Working distance.
b. Arc flash boundary.
c. Incident energy.
d. Required protective fire rated clothing type and class.

2. Provide Arc Flash Warning Label at Maintenance Switch indicting reduced arc-flash requirements when switch in in the enabled/on position. Warning label shall indicate That this label's values only apply when switch is on.

3.7 SERVICE EQUIPMENT FAULT CURRENT MARKING

A. Service equipment shall be legibly marked in the field with the maximum available fault current. The field marking(s) shall include the date the fault-current calculation was performed and be of sufficient durability to withstand the environment involved. The calculation shall be documented and turned over to the owner.

3.8 OVERCURRENT PROTECTIVE DEVICE SETTINGS

A. Manufacturer's Field Service: Engage a factory-authorized service representative of electrical distribution equipment being set and adjusted to assist in setting of over-current protective devices within equipment.

B. Testing: Engage qualified independent testing agency to perform the following device setting and to prepare test reports.

1. Verify that overcurrent protective devices meet parameters used in studies.
2. Adjust devices to values listed in study results.

END OF SECTION

SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Time Clocks.
2. Lighting Contactors.
3. Switchbox-Mounted Time Switches.
4. Automatic Load Control Relays (ALCR)
5. Branch Circuit Emergency Lighting Transfer Switch (BCELTS)
6. Conductors and Cables.
7. Switchbox-Mounted Stand-Alone Controls
8. Wired Lighting Controls and Wireless Lighting Controls.
    a. Indoor Occupancy and Vacancy Sensors.
    b. Daylight Sensors.
    c. High Bay Sensors.
    d. Load Controllers.
    e. Network Integration Controllers.

B. Related Sections include the following:

1. Division 26 Section "Wiring Devices" for wall-box dimmers, and manual light switches.

1.3 SYSTEM DESCRIPTION

A. Occupancy and Vacancy Sensors

1. Occupancy and Vacancy sensors shown on drawings are intended to show control intent. Quantities and locations are approximate and may not include all devices required for 100% coverage to meet energy code requirements. It shall be the contractor's responsibility to provide a complete Occupancy/Vacancy Sensor system based on the performance requirements of this specification and energy code requirements.

2. Daylight harvesting zones are not depicted on the design documents. Zones, quantities of sensors, and location shall be the contractor's responsibility to provide a complete daylight harvesting system based on the performance requirements of this specification and the energy code requirements.]

3. General Requirements

a. Individual Offices: Switchbox or Ceiling-mounted PIR vacancy sensors with preference of switchbox type unless ceiling mounted shown.

1) Manual on control as required by energy codes.

b. Conference Rooms, Meeting Rooms, Training Rooms, Break Rooms, Multi-Purpose Rooms, Lecture Halls, Storage, and Supply Rooms: Ceiling-mounted Occupancy Sensors.

c. Group Restrooms: Ceiling-mounted PIR sensors

1) ADA restroom stalls require PIR sensor in each ADA stall

d. Individual Restrooms: Switchbox mounted PIR sensors

e. Electrical and Mechanical Rooms: Switchbox-mounted single pole timer switch

f.

g. All other areas: Ceiling-mounted PIR Devices

B. Lighting Control System Dimming Loads

1. Lighting Control Systems are shown or noted on the drawing for design intent and may not include all devices. The contractor shall confirm compatibility between fixture dimming load type and lighting controls device prior to ordering equipment.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show installation details for occupancy sensors.

1. Floor plans indicating exact quantity and locations of devices for 100% sensor coverage based on manufacturer's requirements.

2. Interconnection diagrams showing field-installed wiring.

3. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.

2. Program Software Backup: On USB media. Provide names, versions, and website addresses for locations of installed software.

3. Device address list.

4. Printout of software application and graphic screens.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Faulty operation of lighting control software.

b. Faulty operation of lighting control devices.

B. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL

A. All products listed and labeled by a qualified testing agency and marked for intended location and application.

B. [All lighting control products must meet California Title 24 requirements and listings.]

2.2 TIME CLOCKS

A. Basis of Design Product: Subject to compliance with requirements, provide Intermatic, Inc. ET90000 Series Time Clocks or a comparable product by one of the manufacturers listed below. The listing of a manufacturer as "acceptable" does not imply automatic approval. It is the sole responsibility of the contractor to ensure that any submittals made are for products that meet or exceed the specifications included here.

1. Intermatic, Inc. ET90000 Series

2. Tork ELC Series

B. Electronic Time Clocks: Solid state, programmable, with alphanumeric display; complying with UL 917.

1. Contact Configuration: SPST.

2. Contact Rating: 20A minimum inductive or resistive, 120-277-V ac.

3. Outputs/Circuits: 2 to 16.

4. Input Voltage: Selectable 120, or 277V.

5. Astronomic Time: 365 Day, all circuits.

6. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.

7. Automatic daylight savings time changeover.

8. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

2.3 OUTDOOR PHOTOELECTRIC SWITCHES

A. Basis of Design Product: Subject to compliance with requirements, provide Tork Products 2001 Series for 120 volt and 2002 series for 208 and 277 volts, unless otherwise specified or scheduled on drawings.

1. 120 Volts – Tork Products 2001 Series

2. 208/277 Volts – Tork Products 2002 Series

B. Description: Thermal type, with SPST dry contacts rated for 2000-VA tungsten or 1800-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. Light-Level Monitoring Range: 1 to 15 fc, with an adjustment for turn-on and turn-off levels within that range, and a directional 180-degree swivel to prevent fixed light sources from causing turn-off.

2. Time Delay: One minute minimum, to prevent false operation.

3. Mounting: 180-degree swivel, threaded conduit connection.

2.4 LIGHTING CONTACTORS

A. Basis of Design Product: Subject to compliance with requirements, provide Square D Class 8903 lighting contactors or a comparable product by one of the manufacturers listed below. The listing of a manufacturer as "acceptable" does not imply automatic approval. It is the sole responsibility of the contractor to ensure that any submittals made are for products that meet or exceed the specifications included here.

1. Square D Class 8903.

2. Eaton Corporation.

3. ABB (General Electric).

B. Description: Electrically operated and mechanically held, combination-type lighting contactors with non-fused disconnect, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).

2. Contact Ampere Rating: 30 amp ballast, 20 amp tungsten.

3. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.

4. Enclosure: Comply with NEMA 250.

5. Provide with Hand-Off-Auto Control.

2.5 SWITCHBOX-MOUNTED TIME SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide Wattstopper TS-400 or comparable product by one of the manufacturers listed below. The listing of a manufacturer as "acceptable" does not imply automatic approval. It is the sole responsibility of the contractor to ensure that any submittals made are for products that meet or exceed the specifications included here.

1. Wattstopper TS-400

2. Leviton Mfg. Company Inc.

B. General Requirements for Time Switches: Automatic-wall-switch sensor, suitable for mounting in a single gang switchbox.

1. The digital time switch shall be programmable to turn lights off after a preset time.

2. Voltage: Dual voltage, 120 and 277 V.

3. Switch Rating: Not less than 800-VA ballast at 120 V, 1200-VA ballast at 277 V.

4. Time switch shall be compatible with all electronic ballasts, motor loads, and inductive loads.

5. Time scroll feature shall allow manual overriding of the preset time-out period.

6. Time switch shall have the option for a one second light flash warning at five minutes before the timer runs out and twice when the countdown reaches one minute (when used to control lighting loads).

7. Time switch shall have the option for a beep warning that shall sound every five seconds once the time switch countdown reaches one minute.

8. Time switch shall have manual feature for timer reset where pressing the ON/OFF switch for more than 2 seconds resets the timer to the programmed time-out period.

9. Time switch shall have an electroluminescent backlit Liquid Crystal Display that shows the timer's countdown.

10. Time switch shall be capable of operating as an ON/OFF switch.

C. For safety, the time switch shall have a 100% OFF override switch with no leakage current to the load.

2.6 Branch Circuit Emergency Lighting Transfer Switch (BCELTS)

A. Manufacturer: Provide LVS, Inc. EPC-D-F-ATS or Bodine GDT20AM, UL1008 listed, Branch Circuit Emergency Lighting Transfer Switch complying with NEC 700.24.

B. Description:

1. Automatically illuminate connected emergency loads to full brightness upon utility power interruption, regardless of switch/occupancy sensor/dimmer position.

2. Compatible with 2-wire, 3-wire, 0-10V, & EcoSystem dimming systems & ballasts.

3. Local room switch, dimmer, or lighting control shall control/dim both regular & emergency luminaires at the same level during normal operation.

4. Minimum load rating of 16 Amps at 120V or 277V and be rated for Tungsten and Ballast loads.

5. Accept (120-277V) 50-60Hz Input & Output (voltage tolerance +/- 15%).

6. Include emergency power & regular power indicator LED's & a manual test switch.

7. Accept separate phases on the regular hot, emergency hot, and dimmed hot inputs.

8. Include high voltage input surge protection up to 50,000V.

9. Load contacts shall be able to withstand 10 direct shorts while connected to 20 Amp breaker without permanent damage.

10. Shall not generate any objectionable electrical or mechanical noise.

11. Mount inside a 4-11/16" junction box with an extension box. (total depth at least 4").

12. UL94-V0 or UL94-5VA flame rating.

2.7 Automatic Load Control Relays (ALCR)

A. Manufacturer: Provide LVS, Inc. EPC series, or Bodine GDT series, UL924 listed, Automatic Lighting Control Relay complying with NEC 700.26

1. Switching Loads – LVS Cat # EPC-A-2, Bodine Cat# GDT20AM

2. Dimming or Switching Loads – LVS Cat# EPC-A-2-D, Bodine Cat# GDT20AM

3. DMX Loads – Cat# EPC-DMX

B. Description:

1. Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts.

2. Automatically illuminate connected emergency loads to full brightness upon utility power interruption, regardless of switch/occupancy sensor/dimmer position.

3. Compatible with 2-wire, 3-wire, 0-10V,& EcoSystem dimming systems & ballasts.

4. Local room switch, dimmer, or lighting control shall control dim both regular & emergency luminaires at the same level during normal operation.

5. Minimum load rating of 16 Amps at 120V or 277V and be rated for Tungsten and Ballast loads.

6. Accept (120-277V) 50-60Hz Input & Output.

7. Include integral automatic self-test electronics and a manual test switch.

8. Accept separate phases on the regular hot, emergency hot, and dimmed hot inputs.

9. Shall not generate any objectionable electrical or mechanical noise.

10. Nipple mount to junction box.

11. UL94-V0 or UL94-5VA flame rating.

12. NC dry contact (Fire Alarm) for 24 VDC source capable of forcing the lighting into emergency mode until the terminals are again closed.

2.8 CONDUCTORS AND CABLES

A. Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables".

B. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

D. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

2.9 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. Manufacturer shall match devices used in Wired controls in this specification

B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox using hardwired connection.

1. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.

3. Switch Rating: Not less than 800 VA LED load at 120 V, 1200 VA LED load at 277 V.

C. Wall-Switch Sensor Tag VS or OS:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft..

2. Sensing Technology: PIR.

3. Switch Type: SP, field-selectable automatic "on," or manual "on," automatic "off." Field select to Vacancy Sensor (Manual On) in offices and other spaces as required by code and where noted on the drawings.

4. Capable of controlling load in three-way application.

5. Voltage: Dual voltage - 120 and 277 V.

6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.

7. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.

8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

9. Color: Match color of wiring devices

2.10 WIRED LIGHTING CONTROLS

A. Basis of Design Product: Subject to compliance with requirements, provide Wattstopper DLM Series or a comparable product by one of the manufacturers listed below. The listing of a manufacturer as “acceptable” does not imply automatic approval. It is the sole responsibility of the contractor to ensure that any submittals made are for products that meet or exceed the specifications included here.

1. Wattstopper DLM Series

2. Hubbell NX Distributed Intelligence

3. Acuity nLight Designer Series

B. Indoor Occupancy and Vacancy Sensors

1. General Requirements for Sensors: Wall or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.

a. Operation:

1) Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.

2) Vacancy Sensor: Unless otherwise indicated, turn lights on through manual operation, and turn them off when unoccupied with a time delay for turning the lights off, adjustable over a minimum range of 1 to 30 minutes.

b. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.

c. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source.

d. Mounting:

1) Sensor: Suitable for mounting in any position on a standard outlet box.

2) Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.

3) Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

e. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.

f. Bypass Switch: Override the "on" function in case of sensor failure.

g. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.

2. PIR Type: Ceiling-Mounted; detect occupants in coverage area by their heat and movement.

a. Detection Coverage (Room, Ceiling Mounted): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96 inch high ceiling.

b. Detection Coverage (Corridor, Ceiling Mounted): Detect occupancy within 90 ft. when mounted on a 10 ft. high ceiling.

c. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 sq. ft. when mounted 48 inch above finished floor.

d. Voltage: Dual voltage, 120 and 277 V.

e. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.

C. Daylight Sensors

1. Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, lights are dimmed.

   a. Lighting control set point is based on the following two lighting conditions:

      1) When no daylight is present (target level).

      2) When significant daylight is present.

   b. System programming is done with two hand-held, remote-control tools.

      1) Initial setup tool.

      2) Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

2. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, to detect changes in indoor lighting levels that are perceived by the eye.

3. Electrical Components, Devices, and Accessories:

   a. Sensor Output: zero- to 10-V dc to operate luminaires. Sensor is powered by controller unit.

   b. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc.

D. High Bay Sensors

1. Description: Solid-state unit. The unit is designed to operate with the lamp and ballasts indicated.

   a. Operation: Turn lights on when coverage area is occupied, and to half-power when unoccupied; with a time delay for turning lights to half-power that is adjustable over a minimum range of 1 to 16 minutes.

   b. Continuous Lamp Monitoring: When lamps are dimmed continuously for 24 hours, automatically turn lamps on to full power for 15 minutes for every 24 hours of continuous dimming.

   c. Power: Line voltage.

   d. Operating Ambient Conditions: 32 to 149 deg F.

   e. Mounting: Threaded pipe.

   f. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

   g. Detector Technology: PIR.

2. Detector Coverage: User selectable by interchangeable PIR lenses, suitable for mounting heights from 12 to 50 feet.

3. Accessories: Obtain manufacturer's installation and maintenance kit with laser alignment tool for sensor positioning and power port connectors.

E. Load Controllers

1. Description: Digital room controller capable of accepting input from the lighting control system to provide on/off and/or dimming controls based on occupancy and/or daylight.

2. Load controllers shall comply with the following:

a. Provide 2 – RJ45 connections for system communication.

b. Capable of providing 2 outputs each rated for 1 A load at 277 V ac.

c. Compatible with lighting controls interface.

d. Plenum rated.

F. Plug Load Controllers

1. Description: Digital controller capable of accepting input from the lighting control system to provide on/off control based on occupancy.

2. Plug load controllers shall comply with the following:

a. Provide 2 – RJ45 connections for system communication.

b. Capable of providing a single output rated for 20 A load at 120 V ac.

c. Compatible with lighting controls interface.

d. Plenum rated.

G. Network Integration Controllers

1. Description: Network integration device for centralized configuration, monitoring, and control.

2. Utilizes Ethernet connection for:

a. Networking up controllers together to create a larger system.

b. Remote connectivity capabilities, including monitoring, adjusting of controls, maintaining system date/time, and receiving periodic firmware updates (requires internet connection).

c. Integration with Building Management System (BMS) via native BACnet.

3. A single controller or network of controllers can operate on either a dedicated lighting control only network or can be integrated with a building network as a VLAN.

4. Emergency Mode:

a. Support emergency mode to, when triggered, send lights to defined levels and lock out controls for load controllers equipped with emergency mode.

b. Emergency mode may be activated via:

1) Contact closure input.

2) API integration.

3) Manual activation in software application.

5. Rated for use in air-handling spaces as defined in UL 2043.

6. Provide Ethernet switch(es) as required for inter-controller network wiring per manufacturer's instructions; do not exceed manufacturer's required maximum wiring segment lengths.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected and installation by the contractor "validates" the contractor's examination and acceptance of the device.

3.2 BRANCH CIRCUIT EMERGENCY LIGHTING TRANSFER SWITCH (BCELTS)

A. Install in accessible location above door in room that BCELTS serves.

3.3 AUTOMATIC LIGHTING CONTROL RELAY (ALCR)

A. Install in accessible location above light switch or door in room that ALCR serves.

B. Provide building fire alarm connection to each ALCR to activate override and turn on emergency lights upon activation of the building fire alarm system.

3.4 SENSOR INSTALLATION

A. Comply with NECA 1.

B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

C. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

D. Provide independent supports for sensors if required by ceiling system manufacturer or listing/rating of ceiling system.

3.5 INSTALLATION OF CONTACTORS

A. Comply with NECA 1.

B. Mount electrically-held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.6 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.7 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.

2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a Certified Lighting Controls Acceptance Test Technician (CLCATT) to evaluate lighting control devices and perform tests and inspections.

1. Manufacturer shall include sufficient time for a factory technician to assist the CLCATT.

2. The CLCATT shall create and complete any forms required for the commissioning process to meet state requirements.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to commission and test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Lighting control devices will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.9 ADJUSTING

A. Occupancy Adjustments: When requested within 3 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.

3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.10 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

C. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.11 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

B. All modes and time delays shall be adjusted comply with local code.

C. Engage a factory authorized service representative to demonstrate dimming controls and to train Owner's personnel to adjust, operate and maintain dimming controls.

END OF SECTION

SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:

1. Distribution transformers.

B. Related Sections include the following:

1. Division 26 Section "Seismic Restraint For Electrical Systems" for requirements necessary for compliance with seismic criteria.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, vibration isolation devices, and performance for each type and size of transformer indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification: Manufacturer’s certification of seismic qualification according to ASCE 7. Submit ASCE 7 special seismic certification as required. Include method used to determine compliance with requirements.

1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Source quality-control test reports.

C. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled and marked for intended use.

C. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

D. Test and inspect transformers according to IEEE C57.12.91.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.8 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide transformers comparable to Square D or comparable product by one of the following manufacturers. The listing of a manufacturer as “acceptable” does not imply automatic approval. It is the

sole responsibility of the Contractor to ensure that any submittals made are for products that meet or exceed the specifications included here.

1. Square D; a brand of Schneider Electric.
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
3. Siemens Energy & Automation, Inc.
4. ABB (General Electric).

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Aluminum or copper.

D. Nominal System Voltages:

1. Primary voltage 480V 3 phase, delta connected, unless noted otherwise.
2. Secondary voltage 208/120 volts, 3 phase, wye connected, unless noted otherwise.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Provide transformers that are constructed to withstand seismic forces specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Cores: One leg per phase.

D. Enclosure: Ventilated, NEMA 250, Type 2 for indoor transformers.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

E. Enclosure: Ventilated, NEMA 250, Type 3R for outdoor transformers.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

F. Transformer Enclosure Finish: Comply with NEMA 250.

1. Finish Color: Gray.

G. Transformer Taps:

1. Taps for Transformers Smaller Than 3 kVA: None.
2. Taps for Transformers 7.5 to 24 kVA: Two 5 percent taps below rated voltage.
3. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

H. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.

I. Energy Efficiency for Transformers Rated 15 kVA and Larger:

1. Complying DOE 2016 Energy Compliance Standards.
2. Tested according to NEMA TP 2.
3. Label in accordance with NEMA TP 3 requirements.

J. K-Factor Rating (where noted on plans): Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.

1. Provide K-13 rated transformers
2. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
3. Indicate value of K-factor on transformer nameplate.

K. Electrostatic Shielding (where noted on plans): Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding the shield.
3. Shield Effectiveness:

   a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
   b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
   c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.

L. Wall Brackets: Manufacturer's standard brackets. Provide for wall mounted transformers indicated on drawings.

M. Low Sound-Level Requirements: Shall not exceed NEMA ST20 standard sound levels when factory tested according to IEEE C57.12.91.

1. 9 kVA and Less: 40 dba.
2. 30 to 50 kVA: 45 dBA.
3. 51 to 150 kVA: 50 dBA.
4. 151 to 300 kVA: 55 dBA.

5. 301 to 500 kVA: 60 dBA.
6. 501 to 750 kVA: 62 dBA.
7. 751 to 1000 kVA: 64 dBA.

2.4 VIBRATION ISOLATION DEVICES

A. Manufacturer: Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries products specified herein or a comparable product by one of the following:

1. Mason Industries
2. Korfund Company
3. Amber-Booth Company
4. Consolidated Kinetics Corporation
5. M.W. Sausse.

B. All isolation devices shall be designed for the equipment with which they will be used. Materials used shall retain their isolation characteristics for the life of the equipment served. All elastomeric materials shall be industrial grade neoprene. Isolation devices subject to weather shall have hot dipped galvanized finish.

C. Type 6 Mounts: Mason type BR bridge-bearing neoprene mounts with minimum static deflection of 0.2 inches, all directional seismic capability, and consisting of a ductile iron casting containing 2 separated and opposing molded neoprene elements.

D. Type 6 Hangers: Mason type PC30N, vibration hangers similar to type 5, but pre-compressed to the rated deflection so as to keep the piping or equipment at a fixed elevation during installation. Design hangers with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load.

2.5 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

C. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 VIBRATION ISOLATION APPLICATION

A. Use type 6 mounts for transformers installed on concrete slabs and where supports and attachments must meet seismic forces defined in ASCE 7.

B. Use type 6 hangers for suspended transformers where supports and attachments must meet seismic forces defined in ASCE 7.

3.3 INSTALLATION

A. Comply with mounting and anchoring requirements for seismic installations.

B. Equipment Mounting: Install transformers on concrete bases complying with Division 26 Section "Common Work Results for Electrical."

C. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

D. Set transformers plumb and level.

E. Install vibration isolation devices according to Manufacturer’s written instructions.

F. Suspended transformers shall be coordinated with structure with hangers sized to handle transformer physical weight.

G. Maintain a minimum distance of 6 inches from transformer enclosure to adjacent surfaces and equipment.

3.4 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Perform visual and mechanical inspection and electrical tests. Test procedures and values shall be in accordance with NETA-2007 requirements. Certify compliance with test parameters.
2. Compare equipment nameplate data with drawings and specifications.
3. Inspect physical and mechanical condition, anchorage, alignment, and grounding
4. Verify that resilient mounts are free and that any shipping brackets have been removed.
5. Verify the unit is clean.
6. Inspect bolted electrical connections for high resistance

    a. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA-2007, Table 100.12.
    b. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.

7. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage in accordance with manufacturer's published data or in the absence of manufacturer's published data, use NETA-2007, Table 100.5.
8. Verify correct secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.

B. Remove and replace units that do not pass tests or inspections and retest as specified above.

C. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

D. Any transformers deemed to be noisy by Engineer shall have actual dB level of transformer verified by manufacturer. Any transformer exceeding NEMA standard sound levels shall be replaced.

3.6 ADJUSTING

A. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit voltage readings and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.7 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Disconnecting and Overcurrent Protective Devices

B. Related Sections include the following:

1. Division 26 Section "Seismic Restraint For Electrical Systems" for requirements necessary for compliance with seismic criteria.
2. Division 26 Section "Isolation Panelboards."
3. Division 26 Section "Surge Protective Devices for Low-Voltage Electrical Power Circuits" for SPD additional requirements.
4. Division 26 Section "System Studies."
5. Division 26 Section "Fuses"

1.3 ACTION SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective devices, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and electrical ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
6. Include wiring diagrams for power, signal, and control wiring.
7. Field quality control test results
8. Operating and Maintenance data.

C. Coordination Study.

1. Submit a coordination study in conjunction with panelboards showing that all CEC **Article 517 – Life Safety, Critical, and Equipment branches are selectively coordinated as required by code. Normal breakers shall coordinate with load side of respective ATSs. Panelboard shop drawings will not be approved until the coordination study is reviewed, approved. Refer to additional requirements of Division 26 Section "System Studies."**

a. Provide Solid State and/or adjustable trip breakers as required to achieve coordination.

2. Submit a coordination study in conjunction with panelboards showing that the Normal branch overcurrent devices are selectively coordinated as required by code. Panelboard shop drawings will not be approved until the coordination study is reviewed, approved. Refer to additional requirements of Division 26 Section "System Studies."

a. Provide Solid State and/or adjustable trip breakers as required to achieve coordination.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Seismic Qualification: Manufacturer's certification of seismic qualification according to ASCE 7. Submit ASCE 7 special seismic certification as required. Include method used to determine compliance with requirements.

1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.
3. Copies of all panelboard typewritten directories.

B. Record Drawings: Create and submit record drawings including the final version of each panel schedule after load balancing. Create drawings matching the record set and incorporate final panel schedules on drawing and add panel schedule sheets to drawing index.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled by a qualified testing agency and marked for intended location and application.

C. Comply with National Electrical Manufacturer’s Association (NEMA) Standards Publication Number PB1.1 and PB 1.2.

D. Comply with NEMA PB 1.

E. Comply with all applicable codes.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards.

B. Do not store panelboards exposed to weather.

C. Handle and prepare panelboards for installation according to NEMA PB 1.

D. Protect panelboards against damage from work of other trades.

1.8 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.9 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with freestanding panelboards with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: spares for each panelboard as shown on one the Panel Schedules.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Basis-of-Design Manufacturer: Subject to compliance with requirements, provide Square D or comparable product by one of the following. The listing of a manufacturer as “acceptable” does not imply automatic approval. It is the sole responsibility of the Contractor to ensure that any submittals made are for products that meet or exceed the specifications included here.

1. Square D; a brand of Schneider Electric.
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
3. Siemens Energy & Automation, Inc.
4. ABB (General Electric).

B. Panelboard references in this section applies to all panelboards, distribution panelboards, lighting and appliance branch-circuit panelboards and load centers, unless noted otherwise.

C. Except as otherwise indicated, provide panelboards, enclosures and ancillary components, of types, sizes, and ratings indicated, which comply with manufacturer’s standard materials; design and construction in accordance with published product information; equip with proper number of unit panelboard devices as required for complete installation. Where types, sizes or ratings are not indicated, comply with NFPA 70, UL and established industry standards for those applications indicated. Provide circuit directory

in clear plastic cover. Provide panelboards with lugs suitable for termination of feeder sizes indicated on drawings.

1. Panel schedules represent the minimum requirements for items like bus amps and number of breakers. If requirements indicated are not a manufacturer's standard rating, the next higher rating or quantity shall be required.

D. Each panelboard as complete unit shall have a short circuit current rating equal to or great than the integrated equipment rating shown on the panelboard schedule or on the plans. This rating shall be established by testing with the overcurrent devices mounted in the panelboard. Panelboards shall be marked with their maximum short circuit current rating at the supply voltage.

E. Enclosures: Flush and surface mounted cabinets. Refer to panel schedule and floor plans for types of panel cabinets required.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: Type 1.
b. Outdoor Locations: Type 3R**.**
c. Outdoor Locations or Enclosed Locations subject to salt air: Type 4X, 316 stainless steel.
d. Kitchen and wash-down areas: Type 4X, 316 Stainless Steel gasketed cover with Type 1 back box for recessed panels.
e. Pool and Water Equipment room with salt water, chlorine, or chemical storage: Type 4X, 316 Stainless Steel.
f. Other Wet or Damp Indoor Locations: Type 4.
g. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Non-corrosive Liquids: Type 12.
h. Hazardous Areas Indicated on Drawings: Type 9.

2. Back Boxes: Galvanized steel.
3. Directory Card: Inside panelboard door, mounted in transparent card holder.

F. Incoming Mains Location: Top or bottom. Mains location is at the contactor's option as project conditions dictate, unless specifically indicated otherwise on the drawings.

G. Phase, Neutral, and Ground Buses:

1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity or tin-plated, high-strength, electrical-grade aluminum alloy.
2. Equipment Ground Bus: Copper, adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
3. Isolated Ground Bus: Copper, Adequate for branch-circuit isolated ground conductors; insulated from box where specifically noted on the panel schedules or one line diagram.
4. Provide 200 percent capacity neutral bus and lugs on panels where specifically noted on the panel schedules or one line diagram.

H. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type. Lugs shall be of sizes as required to accept feeders as indicated on the drawings.
4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
6. Gutter-Tap Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

I. Service Equipment Label: NRTL labeled for use as service equipment for panelboardswith one or more main service disconnecting and overcurrent protective devices.

J. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

K. Short-Circuit Current Rating: **Fully rated** to interrupt symmetrical short-circuit current available at terminals. Series rated panels and/or breakers are not approved.

2.2 DISTRIBUTION PANELBOARDS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D I-Line type distribution panelboards or comparable product by one of the manufacturers listed above.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Provide full height hinged trim integrated into front cover to allow access to wire gutters without the removal of cover. Provide hinged door for access to overcurrent devices.

D. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches high, provide two latches, keyed alike.

E. Mains: Circuit breaker or main lugs only as indicated on the Panel Schedules.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: bolt-on circuit breakers.

G. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger than 125 A: Bolt-on circuit breakers or plug-in circuit breakers, where individual positive-locking device requires mechanical release for removal.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D NQ series panelboards or comparable product by one of the manufacturers listed above.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or main lugs only as indicated on the on the Panel Schedules.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

F. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Provide full height hinged trim integrated into front cover to allow access to wire gutters without the removal of cover. Provide hinged door for access to overcurrent devices.

G. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.4 REQUIRED SURGE PROTECTIVE DEVICES (SPDs)

A. Panelboards that are part of the Essential electrical distribution system branches shall have an SPD provided in accordance with Specification 264313 “Surge Protective Devices For Low-Voltage Electrical Power Circuits.”

B. Provide 30 amp, 3 pole circuit breaker to serve each SPD in panelboard.

C. Provide SPD regardless if shown on electrical one-line, riser, and/or plans or not.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers listed above.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Solid State (SS), electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and I^2t response (Provide ground fault only where indicated on drawings.)

4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor materials.

5. Provide the following where noted on the drawings or schedules (CB OPT):

    a. GFCI Circuit Breakers (GF): Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
    b. Ground-Fault Equipment Protection (EP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
    c. Dual Function Circuit Breakers (AF/GF): Combination Arc Fault and Ground Fault Circuit Interrupters (Dual Function) provide overload and short circuit protection, plus ground fault protection in accordance with the NEC, UP1699 and UL943.
    d. Shunt Trip (ST): 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
    e. Handle Clamp: Loose attachment, for holding circuit breaker handle in the on position.
    f. Lockable (L): Fixed attachment for padlocking circuit breaker handle in the on or off position. In addition to where noted on drawings or schedules, lockable breakers shall be provided for all Fire Alarm cabinets, and hard wired electric water coolers.
    g. Fire Alarm/NFPA 72 System (FA): Fixed attachment for maintaining breaker handle in on position. In addition to where noted on drawings or schedules, lock-on breakers shall be provided for all Fire Alarm and/or NFPA 72 systems as required.

6. Provide ground fault protection for all overcurrent devices rated 1000 amps and larger serving 480 volt branch circuits, feeders, and/or equipment.

2.6 ARC-FLASH LIMITING CIRCUIT BREAKERS - ENERGY-REDUCING MAINTENANCE SWITCH (ERMS)

A. Provide on all breaker frames 1200 amps and higher independent of trip plug rating.

B. Circuit breakers shall be without current-limiting fuses, listed as complying with UL 1066.

C. Short-circuit withstand current rating shall be 200 kA.

D. Equip the arc-flash limiting feeder circuit breakers with Arc-Flash Maintenance Setting switch for use as a temporary arc-flash incident energy-reduction device during maintenance activities on that feeder.

1. Provide a manual switch on the compartment door to switch the circuit-breaker short-time tripping characteristics to instantaneous with minimum pickup setting, to reduce the danger from potential arc-flash at downstream equipment.
2. Provide a lock feature for the switch so that it may be locked in either the off or on maintenance-mode position.
3. Provide a blue LED indicating light to indicate that the switch is in maintenance mode.
4. Provide dry relay contacts on each switch for annunciation of the switch position.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panelboards and accessories according to manufacturer’s written instructions, according to NEMA PB 1.1, and in accordance with recognized industry standards.

B. Mount panelboards recessed within a wall or surface mounted as indicated on drawings and schedules.

C. Support panel cabinets independently to structure with no weight bearing on conduits.

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

E. Comply with mounting and anchoring requirements for seismic installations.

F. Mount so that top breaker is not higher than 6'-0" AFF, unless otherwise indicated.

G. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush and tight with wall finish and mating with back box.

H. Adjacent panel cabinets shall be of same physical size and mounted in horizontal alignment.

I. Provide lugs in panelboards of adequate size to accept feeders as indicated on drawings.

J. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.
2. Install filler plates in unused spaces.
3. Provide lock-on, red, handle clamp accessory for any circuit breaker serving fire alarm control panels, fire alarm power supplies, or any other NFPA 72 system as required.
4. Provide lockable handle padlock circuit breaker attachment where noted on panel schedules or plans as lockable option.

K. Provide one ¾" empty conduit for each three panel spaces and/or spares between recessed panelboards and accessible ceiling space or space designated to be ceiling space in the future, for future use.

L. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable. Verify actual room names and numbers to be used, and include room name, room number and name of load being served for every circuit.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
2. Megger check and test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit. Do not megger check solid-state components.
3. Test continuity of each circuit.
4. Energize each circuit and check for complete function.
5. Each level of equipment ground-fault protection shall be performance tested to ensure compliance with NFPA 70. Article 517-17(b). Document test results and include with close-out documents. Provide test equipment for performance testing of equipment ground-fault protection at 100% HCAI inspection.
6. Set adjustable trip circuit breakers in accordance with coordination study.
7. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
c. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

B. Panelboards will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

D. Touch up paint scratched or marred surfaces to match original finish.

3.5 ADJUSTING AND CLEANING

A. Adjust moving parts and operable component to function smoothly and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "System Studies."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 10 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

D. Tighten lugs and bus connections.

E. Clean interior of panelboard.

END OF SECTION

SECTION 26 24 17 – ISOLATION PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Isolation panels
2. Line isolation monitors

B. Related Sections include the following:

1. Division 26 Section "Seismic Restraint For Electrical Systems" for requirements necessary for compliance with seismic criteria.

1.3 ACTION SUBMITTALS

A. Product Data: For each isolation panel, line isolation monitor, and component indicated, include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each isolation power panel and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and electrical ratings.
2. Detail enclosure types and details.
3. Detail bus configuration, transformer, current, and voltage ratings.
4. Include wiring diagrams for power, signal, and control wiring.
5. Field quality control test results
6. Operating and Maintenance data.
7. Line isolation monitor equipment information sheet(s).
8. Panel cover dimensions, construction, and material information.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification: Manufacturer’s certification of seismic qualification according to ASCE 7. Submit ASCE 7 special seismic certification as required. Include method used to determine compliance with requirements.

1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

C. Record Drawings: Create and submit record drawings including the final version of each panel schedule. Create drawings matching the record set and incorporate final panel schedules on drawing and add panel schedule sheets to drawing index.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain isolation panels and line isolation monitors from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 articles, and NFPA 99, by a qualified testing agency, and marked for intended location and application.

C. Codes and Standards.

1. UL Standard 1047 Isolated Power Systems Equipment
2. National Electrical Manufacturers' Association (NEMA)
3. National Electrical Contractors Association (NECA)
4. National Fire Protection Association (NFPA) 70
5. National Fire Protection Association (NFPA) 99 Standard for Healthcare Facilities
6. Guidelines for Design and Construction of Health Care Facilities

1.6 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside isolation panelboards.

B. Do not store isolation panelboards exposed to weather.

C. Handle and prepare isolation panelboards for installation according to NEMA PB 1.

D. Protect panelboards against damage from work of other trades.

1.7 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install isolation panels until spaces are enclosed and weather-tight, wet work in spaces is complete and dry, work above isolation panel is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.8 COORDINATION

A. Coordinate layout and installation of isolation panels and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide isolation panels and line isolation monitors comparable to Square D or comparable product by one of the following manufacturers. The listing of a manufacturer as “acceptable” does not imply automatic approval. It is the sole responsibility of the Contractor to ensure that any submittals made are for products that meet or exceed the specifications included here.

1. Square D; a brand of Schneider Electric.
2. Isotrol
3. Post Glover

2.2 REQUIREMENTS FOR ISOLATION PANELS

A. Provide isolation panels in operating rooms cardiac intensive care rooms intensive care rooms and cath labs anesthetizing areas as indicated on the drawings.

B. Factory wired and tested with shielded low leakage isolating transformer, primary and secondary circuit breakers, and line isolation monitors.

C. Each panelboard, as complete unit, shall have a short circuit current rating equal to or great than the integrated equipment rating shown on the panelboard schedule or on the plans. This rating shall be established by testing with the overcurrent devices mounted in the panelboard. Panelboards shall be marked with their maximum short circuit current rating at the supply voltage. All panelboards shall be fully rated; series rated panels are not approved.

2.3 ENCLOSURES

A. Refer to panel schedule and floor plans for types of panel cabinets required.

1. Rated for environmental conditions at installed location. Totally enclosed non-vented enclosure.
2. Temperature: Design the enclosure and transformer to prevent full load heat losses from affecting the operation of breakers and line isolation monitors. Full load continuous operation front panel temperature designed to be below 30 degrees Celsius. Make temperature test available upon request from engineer.
3. Front: For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Provide concealed continuous hinged, keyed lock door for access to overcurrent devices and line isolation monitor along with provisions for testing. Use type 304 stainless steel in a number 4 brushed finish. Use deadfront construction.
4. Back Boxes: 14 gauge steel, degreased, primed and finish panted.
5. Directory Card: Inside panelboard door, mounted in transparent card holder.
6. Depth: 3kVA to 5kVA 8-inches; 7.5kVA to 10kVA 12-inches.

B. Ground Bus:

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Locate in panel with lugs for up to #1/0 connection.

2.4 TRANSFORMER

A. Wound with electrostatic shield between primary and secondary windings, grounded to enclosure. Electrostatic shield made to prevent a direct short of primary to secondary winding and to reduce the coupling of harmonic distortions between the primary circuit and secondary circuits.

B. Transformer secondary total leakage current shall be below 20 microamperes

C. Sound ratings shall not exceed 30dB for 5kVA and under and 35dB for 7.5kVA and above. Internally isolate the core and coil from the enclosure.

D. Primary and secondary voltage shall be as indicated on the drawings.

E. Transformer(s) to be 480 volts, single phase primary and 120V single phase secondary or as indicated on drawings.

F. Rated 60Hz.

G. Class H rated insulation shall be used in the manufacture of the transformer and the temperature rise shall be limited to 55 degrees C. above ambient under full load conditions when tested in accordance with NEMA-ANSI Standards. Transformers shall have a 220 degree C. UL recognized insulation system. The core and coil shall be vacuum

impregnated and shall have a final wrap of insulating materials so as not to expose and bare conductor.

H. Provide transformer sizes as indicated on the drawings.

I. Provide 3kVA, 5kVA, 7.5kVA, 10kVA transformers.

2.5 CIRCUIT BREAKERS

A. Provide 2-pole bolt-on type circuit breakers with minimum interrupting capacity of 10,000 amperes.

B. Provide a 16 circuit breaker panel.

C. Provide panel with circuit breakers as indicated on drawings.

2.6 LINE ISOLATION MONITOR (LIM)

A. Line isolation monitor shall utilize dynamic ground detector and contribute no more than 50 microamperes to leakage current.

B. Provide two channel circuit that continually monitors the impedance from both lines to ground. LIM designed to switch between either line to ground is not acceptable.

C. Provide momentary test switch that verifies operational integrity. A test switch with manual reset is not acceptable.

D. Use fuses accessible from the front of the panel or mounted inside the panel to protect the LIM.

E. LIM's meter shall provide a continuous visual indication of the total hazard current in the monitored system. Display shall use a green safe light and red hazard light on the front of the panel.

F. Provide a unique audible and visual alarm indication of a lost ground connection to the unit.

G. Provide a silence switch.

H. Provide an external set of normally open and normally closed dry contacts that operate to indicate the LIM's hazard condition. Contacts are available for connection to external monitoring system such as a building automation system (BAS).

I. Alarm threshold shall be 5 milliamperes total hazard current under nominal line voltage conditions. The alarm band differential shall be 250 microamperes or less at nominal line voltage.

J. LIM shall be UL recognized under UL Subject 1022.

2.7 SECONDARY BRANCH CIRCUIT WIRING

A. Use cross linked polyethylene insulation type XHHW conductors with a dielectric constant of 3.5 or less.

B. Minimum insulation wall thickness shall be 4/64 inch for AWG #10 and AWG #12; and 5/64 inch for AWG #8 and larger.

C. Use stranded copper conductors.

2.8 GROUND INTEGRITY TESTER

A. Provide a portable ground integrity tester catalog number MVO-1-PB by Hampden Engineering Co. with MVO-60Hz-IT 60Hz test accessory.

B. The unit shall be capable of accurately measuring voltage potential between any two conductive surfaces or a conductive surface and an equalizer ground bus; in the range of 0 to 8 millivolt. Instrument will be self powered with no connection to an outside voltage source required. The meter scale will be green in the 0-5 millivolt range and red in the 5 to 8 millivolt range. The instrument shall withstand accidental exposure to 300 volts across the probes without damaging the unit's accuracy or operation.

C. The instrument shall incorporate a second testing mode for checking resistance of ground circuits. The scale for this mode shall be calibrated in ohms, the 0 to 0.1 ohm portion of the scale is green and the portion above 0.1 ohm is red.

D. Provide 10 foot calibrated test leads for resistance measurements and shielded 15 foot leads for the voltage potential difference test.

E. Instrument shall have provision for battery testing and pre-calibrated 3MV and 0.1 ohm test points.

F. The enclosure containing all electrical components shall be insulated to prevent accidental exposure of test circuits to outside voltage sources. Construct the case with molded polyester material.

G. Provide a unit that is capable of use while a patient is present. The unit shall in no way induce voltage potential which may endanger a patient or operating personnel. To assure safety and reliability provide a unit manufactured in accordance with MIL Q 9858A. Submit the current approval to manufacture under MIL Q 9858A. Manufacturer to submit information confirming that he has similar units operating in the field for one or more years.

H. Tester to become the property of the Owner.

2.9 PORTABLE LEAKAGE CURRENT TESTER

A. Provide a portable leakage current meter capable of checking ground wire continuity and indicating total appliance leakage to ground. Instrument must be able to operate from either a grounded or isolated power supply and must be able to indicate leakage to patient leads with appliance ground wire continuity or when ground wire is opened. Provisions for simulating an open appliance ground wire shall be incorporated in the instrument.

B. The instrument must contain straight blade type, 20 ampere receptacles. All instrument readings must be accurate within 5%, and the maximum allowable leakage of the instrument itself is not to exceed 1 microampere. Unit must be digital reading and contain automatic ranging over scales of 0 to 10 microamperes, 0 to 0.1 milliamperes and 0 to 1 milliamperes. The leakage current tester shall be as manufactured by Fluke/Dale Technology, Cat. No. DALE 2000 LIM/GFI Tester.

C. Tester to become property of the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Exam area to receive isolation panel and verify adequate clearances prior to installation

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Provide remote line isolation monitor in rooms where isolation panel is outside of the room served.

B. Connect the ground terminal of each receptacle to the isolation panel ground bus.

C. Install according to manufacturer’s written instruction, applicable requirement of NFPA 70 and NECA’s Standard of Installation and in accordance with recognized industry practices.

D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed within a wall or surface mounted as indicated on drawings and schedules. Install to allow cover to be drawn tight against wall and to provide a neat appearance.

E. Support panel cabinets independently to structure with no weight bearing on conduits.

F. Comply with mounting and anchoring requirements for seismic installations.

G. Mount so that top breaker is not higher than 6'-0" AFF, unless otherwise indicated.

H. Install filler plates in unused breaker spaces.

I. Provide ¾" empty conduit for each unused breaker or provisional space from the panel to accessible space.

J. Install isolated circuit conductors in galvanized rigid steel conduit (GRC)

K. Do not use pulling compound or use a dry pulling compound such as talcum powder. Do not use wet pulling compounds because they increase the leakage current of the circuit. Take care while pulling to avoid scrapes, nicks or damage to insulation.

L. Minimize circuit lengths to reduce leakage current.

M. Install no more than one circuit per conduit.

N. Circuits failing to meet manufacturer's or NFPA 99 leakage current criteria shall be reworked until circuit is within tolerance.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable. Verify actual room names and numbers to be used, and include room name, room number and name of load being served for every circuit.

C. Nameplates: Label each isolation panel with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Color code wiring in accordance with NFPA 70 Article 517 and NFPA 99.

3.4 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Include the cost of testing all isolated power systems.
2. Engage a qualified factory technician to provide testing of the installed system.
3. Verify proper polarity of each circuit.

4. Verify installation is in accordance with contract documents, authority having jurisdiction requirements, and applicable codes..

B. Perform field test prior to energization to verify installation, code, and contract document compliance.

C. Tests and Inspections:

1. Inspect all connections and materials used. Document the Test in accordance with NFPA 70 Article 517 and NFPA 99.
2. Factory technician shall check, record, and submit leakage current results. Factory technician shall simulate faults, combinations of resistive and capacitive faults, at each outlet served by the isolated power system using a fault magnitude selected to just exceed the LIM hazard threshold to ensure correct operation of the LIM.

D. Isolation power systems will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies the isolation panelboards compliance with NFPA 99 and any corrective measures taken. Submit the report.

F. Touch up scratched or marred surfaces to match original finish or replace if touch-up is unsuccessful.

3.5 ADJUSTING AND CLEANING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Tighten lugs and bus connections.

C. Clean interior of panelboard.

3.6 OWNER TRAINING

A. Engage factory technician to instruct Owner in use and maintenance of the panel and line isolation monitor as a leakage measuring device.

B. Engage the factory technician to instruct and train the Owner in the means and methods of performing recurring maintenance and testing required by NFPA 99. Instruct and train the Owner in methods for logging mandated maintenance and testing.

C. Engage the factory technician to instruct the Owner in the application of leakage testing for appliance to be connected to the isolated power systems.

D. Provide logbooks with acceptance testing entries represented. Arrange the log book for the Owner to use as part of their testing and include detailed instructions of the testing and logging procedures.

E. Allow sufficient notification for Owner and Engineer regarding testing observation, training, and instruction so that the Owner and Engineer can arrange to have the appropriate personnel in attendance.

F. Engage factory technician inclusive of travel, lodging, meals, and sufficient time to accomplish the tasks identified herein.

END OF SECTION

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Receptacles.
2. Receptacles with integral GFCI.
3. Twist-locking receptacles.
4. Receptacles with integral surge suppression units.
5. Isolated-ground receptacles.
6. Hospital-grade receptacles.
7. Snap switches and wall-box dimmers.
8. Solid-state fan speed controls.
9. Device face plates.
10. Momentary Contact Switches

1.3 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. RFI: Radio-frequency interference.

C. TVSS: Transient voltage surge suppressor.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.6 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.8 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source unless noted otherwise.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
2. Leviton Mfg. Company Inc. (Leviton).
3. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 DEVICE COLORS

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Wiring Devices Connected to Normal Power System: White, unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Generator Power System: Red.
3. Isolated-Ground Receptacles: Color of wiring device with orange triangle.

2.3 STRAIGHT BLADE RECEPTACLES

A. General:

1. Hospital-Grade, Duplex Convenience Receptacles, 125 V, 20 A, 5-20R configuration: Comply with NEMA WD 1, NEMA WD 6, UL 498 Supplement SD, and FS W-C-596.

B. Heavy-Duty, Simplex:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Pass & Seymour – 8301
   b. Hubbell – HBL8310
   c. Leviton – 8310

C. Heavy-Duty Duplex:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Pass & Seymour – 8300
   b. Hubbell – HBL8300
   c. Leviton – 8300

D. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Products: Subject to compliance with requirements, provide one of the following:

   a. Pass & Seymour – TR63H
   b. Hubbell – HBL8300-SG
   c. Leviton – 8300-SG

2. Labeled to comply with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

E. Controlled Duplex Receptacles:

1. Duplex Convenience Receptacles, 125 V, 20 A.
2. Device marked as controlled receptacle.
3. Products: Subject to compliance with requirements, provide one of the following:

   a. Pass & Seymour – 5362CD
   b. Hubbell – BR20C2
   c. Leviton – 5362-2P

F. Combination USB-A / USB-C Duplex Receptacles:

1. Duplex Convenience Receptacles, 125 V, 20 A, tamper resistant.
2. Device shall incorporate (1) USB-A port, (1) USB-C, and (2) AC outlets.
3. Products: Subject to compliance with requirements, provide one of the following:

   a. Pass & Seymour – TR2OHUSBAC
   b. Hubbell – USB8200AC
   c. Leviton – T5833-HG

G. Outdoor and Damp/Wet Locations Weather Resistant Combination USB-A/USB-C Duplex Receptacles:

1. Duplex Convenience Receptacles, 125 V, 20 A, tamper resistant.
2. Device shall incorporate (1) USB-A port, (1) USB-C, and (2) AC outlets.

3. Products: Subject to compliance with requirements, provide one of the following:

   a. Pass & Seymour – WRTR20USBAC6
   b. Hubbell – USB20AC5WWR

H. Ground-Fault Circuit Interrupters:

1. General Description: Hospital-Grade, duplex, feed-through type. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

   a. Receptacle shall be capable of being installed in a 2-1/2 inch deep outlet box without adapter.
   b. Shall be grounding type with solid-state ground fault sensing and signaling; with 5 milliamperes ground fault trip level.
   c. Test and reset buttons shall match color of face.
   d. If critical components within receptacle are damaged and the ground fault protection is lost, power to receptacle shall be automatically disconnected within the device.
   e. Receptacle shall automatically monitor ground fault circuit interrupting functionality at a maximum of every (3) hours. If receptacle can no longer provide GFCI protection, it must deny power and provide a visual indication that it is no longer functional.
   f. Receptacle shall deny power if line conductors are incorrectly wired to the load terminals.

2. Products: Subject to compliance with requirements, provide one of the following:

   a. Indoor – Dry Locations (Tamper Resistant):

      1) Pass & Seymour – 2097HGTR
      2) Hubbell – GFTWRST83
      3) Leviton – GFTR2-HG

   b. Outdoor and Damp/Wet Locations:

      1) Pass & Seymour – 2097TRWR
      2) Hubbell – GFTWRST83
      3) Leviton – GFWT2-HG

   c. Outdoor and Damp/Wet Locations Combination USB-A/USB-C Duplex **(non-patient care areas only**):

      1) Pass & Seymour – 2097TRWRUSBAC

I. Duplex Convenience Isolated Ground Receptacles:

1. Straight blade, 2 pole, 3 wire, grounding type, NEMA 5-20R configuration, orange triangle indication, with provision for back or side wiring and rated 20 amperes, 125 volt, AC. 'Hospital' grade.

   a. Device color shall match non isolated ground receptacles and have an orange triangle on the device.

2. Products: Subject to compliance with requirements, provide one of the following:

   a. Pass & Seymour – IG8300
   b. Hubbell – IG8300
   c. Leviton – 8300IG

3. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

J. Clock-Hanger Receptacle:

1. Provide recessed, 15A, Clock-Hanger type receptacle:
2. Products: Subject to compliance with requirements, provide one of the following:

   a. Pass & Seymour – S3713
   b. Hubbell – HBL5235
   c. Leviton – 5261-CH

K. Special Purpose Receptacle:

1. Manufacturer: Same as general purpose receptacle.
2. Configuration as shown on Drawings.

2.4 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES

A. Wiring Devices for Hazardous (Classified) Locations: Comply with NEMA FB 11 and UL 1010.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Cooper Crouse-Hinds.
   b. EGS/Appleton Electric.
   c. Killark; a division of Hubbell Inc.

2.5 SWITCHES

A. General:

B. Switches shall be rated for 20 amperes, and rated 120/277 volts AC. Switch shall be manufacturer's specification grade toggle switch. Switches shall have quiet action mechanism with silver alloy contacts for longevity. Comply with NEMA WD 1, UL 20, and FS W-S-896.

1. Terminal screws shall allow back and side wiring and accept #14, 12, and 10 AWG stranded or solid wire.

C. Single Pole

1. Products: Subject to compliance with requirements, provide one of the following:

a. Pass & Seymour – PS20AC1
b. Hubbell – HBL1221
c. Leviton – 1221-2

D. Double Pole Single Throw:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Pass & Seymour – PS20AC2
b. Hubbell – HBL1222
c. Leviton – 1222-2

E. Three Way:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Pass & Seymour – PS20AC3
b. Hubbell – HBL1223
c. Leviton – 1223-2

F. Four Way:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Pass & Seymour – PS20AC4
b. Hubbell – HBL1224
c. Leviton – 1224-2

G. Key Switch Locking - Same series devices as above with –L option.

H. Indicator Light – Separate pilot strap, red color.

I. Locator Light – Lighted handle type switch, green color handle.

2.6 DIMMERS - WALL BOX

A. LED Fixtures - 0-10V:

1. Provide branch lighting 0-10V sinking control for fixtures with LED drivers, with electromagnetic filters to reduce noise, RF and TV interference to minimum. Construct with continuously adjustable trim potentiometer for adjustment of low and high end dimming; and with anodized heat sinks. Provide 6 inch wire connecting leads.

a. Shall be Lutron (slide to off) Nova NTSTV-DV.
b. Provide wattage as indicated on drawings.
c. Provide additional interface modules if connected wattage exceeds dimmer rated wattage including any derating of the dimmer as documented by the manufacturer.

B. LED Bulbs in 120V Fixtures with Retrofit LED Bulbs:

1. Provide branch lighting control for LED bulbs, with electromagnetic filters to reduce noise, RF and TV interference to minimum. Construct with continuously adjustable trim potentiometer for adjustment of low and high end dimming; and with anodized heat sinks. Provide 6 inch wire connecting leads.

a. Shall be Lutron (slide to off) Nova NTCL.
b. Provide wattage as indicated on drawings.
c. Use only with LED bulbs marked as dimmable and on the Lutron recommended list.

2.7 FAN SPEED CONTROLS

A. Modular, 120-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters. Comply with UL 1917.

1. Continuously adjustable slider, 6A, (up to 4 fans) 12A (up to 8 fans).
2. Products: Subject to compliance with requirements, provide one of the following:

a. Shall be Lutron type NTFS series.

2.8 WIRING DEVICE ACCESSORIES

A. Wall Plates:

1. Provide wall plates for single and combination wiring devices, of types, sizes, and with ganging and cutouts as indicated. Select plates which mate and match wiring devices to which attached. Construct with metal screws for securing plates to devices; screw heads colored to match finish of plates; wall plates colored to match

wiring devices. Provide plates possessing the following additional construction features:

a. Material and Finish:

1) Stainless Steel (0.04 inch thick type 302 satin finished)

a) All Areas

2. Device plates for surface mounted Type FS or FD boxes: Type FSK galvanized steel covers.
3. Device plates for surface mounted, 4 in. square boxes: 1/2 in. raised galvanized steel covers.

B. Weatherproof Covers:

1. Weatherproof covers for all 125-250 volt, 15 and 20 ampere receptacles installed outdoors or in a wet location shall be weatherproof, NEMA 3R, with hinged outlet enclosure rated for rain proof protection while outlet is in use. The unit shall be furnished with a neoprene gasket between the mounting surface and the enclosure, and between the mounting plate and the hinged cover to assure proper seal.

a. Surface Mounted Type: shall be RedDot, Die Cast with GFCI mounting plate horizontal mount (duplex), CKMU, vertical mount (quad), 2CKU.
b. Recessed/Flush Mounted Type: Shall be Arlington Industries Catalog# DSBVM1W with metal backbox.

2. Weatherproof covers for all free standing outdoor receptacles shall be installed in a 19.5”, low-profile enclosure with built in while in use cover. Shall be bronze in color equal to Arlington Industries GPD19BR.
3. Weatherproof covers for all other receptacles shall be cast aluminum with a gasketed cover. Shall be RedDot DCCD series.
4. Weatherproof covers for switches shall be lever switch type, rugged metallic construction with gasketed cover . Shall be equal to Hubbell-Raco 5121 (single switch), Hubbell-Raco 5124 (two ganged switches), Hubbell-Raco 5126 (three ganged switches).

2.9 SHUNT TRIP STATIONS

1. Products: Subject to compliance with requirements, provide the following or equal:

a. Rockwell Automation: Cat# 800T-NX114

2. Break-Glass Push Button Station Red push button station in a weatherproof enclosure incorporates snap-action contact block with (1) NO and (1) NC contacts, which are operated when the small glass window is broken.

PART 3 - EXECUTION

3.1 INSTALLATOIN

A. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

B. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

a. Cut back and pigtail, or replace all damaged conductors.
b. Straighten conductors that remain and remove corrosion and foreign matter.
c. Pigtailing existing conductors is permitted provided the outlet box is large enough.
d. Connect wiring device grounding terminal to outlet box with bonding jumper and branch circuit equipment grounding conductor.

C. Device Installation:

1. Clean debris from every outlet box; including excess drywall mud.
2. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
3. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
4. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment. Clean exposed surfaces to remove spatters and restore finish.
5. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
6. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.

7. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
8. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
9. Tighten unused terminal screws on the device.
10. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact. Provide extension rings to bring device flush with finished surface (do not use switch box extension rings/goof rings). Install devices plumb, level and rigidly in place.

D. Receptacle Orientation:

1. Vertically Mounted Receptacles - Install ground pin down, and on horizontally mounted receptacles to the left.
2. Horizontally Mounted Receptacles – Install so that Neutral blade is on top.

E. Device Plates:

1. Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
2. Flush mounted, while in use, weatherproof covers shall be used in all public, front of house areas, and on building facades. Surface mounted type, while in use, weatherproof covers shall be used on all surface mounted receptacles.

F. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
4. Verify dimmers achieve full rating of specified/designed load indicated after derating for ganging as instructed by manufacturer.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on bottom. Group adjacent switches under single, multigang wall plates where devices permit.

H. All exterior receptacles shall be GFCI type mounted in weatherproof boxes.

I. Ground receptacles with the insulated green ground wire from device ground screw to a bolted outlet box connection. Isolated ground receptacles shall have the second ground wire (green with yellow tracer) ground the receptacle**.**

J. Provide hospital grade receptacles in all "Patient Care" areas.

K. Provide hospital grade safety type, tamper resistant duplex receptacles in all pediatric locations.

L. This Contractor shall check the switch location against the Architectural plans and shop drawings to be certain that switches are on the strike side of the door, regardless of swing shown on drawings. Edge of plate shall be not more than 12" from door frame.

M. Install emergency switches which occur adjacent to normal light switches in separate boxes to maintain system's isolation in accordance with NFPA 70 required separation.

N. Ground-fault circuit interrupter type receptacles may provide GFCI protection for downstream receptacles on same circuit only where located in same room as other receptacles.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles: Identify panelboard and circuit number from which served on device.
2. Shunt Trip Stations: Identify panel being shunt tripped via placque above station.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.

a. Provide a grounding system test in accordance with NFPA 99 for all receptacles in patient care areas.

2. Test Instruments: Use instruments that comply with UL 1436.
3. Provide operational testing for devices.
4. Test receptacles with Hubbell 5200, Woodhead 1750, or equal, for correct polarity, proper ground connection, and wiring faults.

5. Test straight blade convenience outlets in patient-care areas, hospital-grade convenience outlets for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz..

B. Wiring device will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION

SECTION 26 28 13 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600 V ac and less for use in the following:

a. Control circuits.

b. Panelboards.

c. Enclosed controllers.

d. Enclosed switches.

B. Spare-fuse cabinets.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.

2. Current-limitation curves for fuses with current-limiting characteristics.

3. Fuse sizes for elevator feeders and elevator disconnect switches.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.5 FIELD CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Bussmann, Inc.

2. Edison Fuse, Inc.

3. Ferraz Shawmut, Inc.

4. Littelfuse, Inc.

B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

1. Type RK-5: 0A to 600A rating, 200 kAIC, time delay.

2. Type CC: 0A to 30A rating, 200 kAIC, fast acting.

3. Type J: 0A to 600A rating, 200 kAIC, time delay.

4. Type L: 601- to 6000A rating, 200 kAIC, time delay.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1. Where manufacturer's installation instructions specify fuse type, contractor to provide required fuse type, regardless of what is listed below.

2.3 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.

2. Finish: Gray, baked enamel.

3. Identification: "SPARE FUSES" in 1-1/2-inch-high letters on exterior of door.

4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:

1. Service Entrance: Class L, time delay (200kA Rated).

2. Motor and Equipment Branch Circuits: Class RK5, time delay (200kA Rated).

3. Control Circuits: Class CC, fast acting.

4. Service Entrance: Class L, time delay.

5. Feeders: Class J, time delay, Class L, time delay.

6. Motor Branch Circuits: Class RK5, time delay.

7. Large Motor Branch (601-4000 A): Class L, time delay.

8. Other Branch Circuits: Class RK5, time delay.

9. Control Transformer Circuits: Class CC, time delay, control transformer duty.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is easily readable without removing fuse.

B. Install spare-fuse cabinet(s) in each electrical room serving fused equipment.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION

SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Non-fusible switches.
3. Molded-case circuit breakers (MCCB's).
4. Molded-case switches.
5. Enclosures.

B. Related Sections include the following:

1. Division 26 Section "Seismic Restraint For Electrical Systems" for requirements necessary for compliance with seismic criteria.
2. Division 26 Section “System Studies.”

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).

4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.
2. **Submit a coordination study in conjunction with enclosed circuit breakers showing that all CEC 517 systems are selectively coordinated as required by code. Normal circuit breakers shall coordinate with load side of respective CEC 517 ATSs. Enclosed circuit breaker shop drawings will not be approved until the coordination study is reviewed, approved. Refer to additional requirements of Division 26 Section "System Studies."**

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification: Manufacturer's certification of seismic qualification according to ASCE 7. Submit ASCE 7 special seismic certification as required. Include method used to determine compliance with requirements.

1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Fuse Pullers: Two for each size and type.

1.8 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in California Electrical Code (CEC), by a qualified testing agency, and marked for intended location and application.

C. Comply with [NFPA 70][the CEC].

1.9 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D switches or comparable product by one of the following. The listing of a manufacturer as "acceptable" does not imply automatic approval. It is the sole responsibility of the contractor to ensure that any submittals made are for products that meet or exceed the specifications included here.

1. Square D; a brand of Schneider Electric.
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
3. Siemens Energy & Automation, Inc.
4. ABB (General Electric).

2.2 FUSIBLE SWITCHES

A. Type HD, Heavy Duty, Single Throw, 240 and 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

B. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
6. Hookstick Handle: Allows use of a hookstick to operate the handle.
7. Lugs: Mechanical type, suitable for number, size, and conductor material.
8. Service-Rated Switches: Labeled for use as service equipment.

2.3 NON-FUSIBLE SWITCHES

A. Type HD, Heavy Duty, Single Throw, 240 and 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

B. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
4. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.4 HORSEPOWER RATED SWITCHES

A. Switches utilized for disconnecting means for motors and equipment shall have the following ratings and shall be one of the above specified manufacturer catalog numbers.

1. Rated 30 amps, for motor loads of up to 2 hp at 120 volt and 3 horsepower at 208, 240, and 277 volts.
2. Provide pad lock accessory where required by code to be locking which includes any motor/equipment disconnects serving elevators in machine room or hoistway.
3. Products: Subject to compliance with requirements, provide one of the following:

   a. Pass & Seymour – 7802
   b. Hubbell – HBL7832D
   c. Leviton – MS302-DS

2.5 MOLDED-CASE CIRCUIT BREAKERS

A. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents indicated on the drawings.

B. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits in each pole. Adjustable magnetic trip setting for circuit-breaker frame sizes 150 A and larger, adjustable from the front.

C. Construct with over center, trip-free toggle type operating mechanisms with quick make, quick break action and positive handle trip indication. Construct breakers for mounting and operating in any physical position. Provide breakers lugs AL/CU rated. Lugs shall be adequate to accept wire size indicated on the drawings.

D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Instantaneous trip.
2. Long- and short-time pickup levels.
3. Long- and short-time time adjustments.
4. Ground-fault pickup level, time delay, and I^2t response (Provide ground fault only where indicated on drawings.)

F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

G. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA or more trip and hold below 4mA of ground fault current). One way circuit length shall not exceed 250 feet. If length exceeds 250 feet, notify engineer in writing prior to installing circuit.

H. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip). Provide as noted on plans and/or panel schedules and for all circuits supplying power to heat trace.

I. Where required to achieve system coordination with upstream and downstream overcurrent devices, solid-state circuit breakers shall be provided. All electronics shall be self-contained and require no external relaying, power supply, or accessories. Printed circuit cards shall be treated to resist moisture absorption, fungus growth, and signal leakage. All electronics shall be housed in an enclosure which provides protection against arcs, magnetic interference, dust, and other contaminants. Solid-sate sensing shall measure true RMS current with error less than one percent on systems with distortions through the 13^{th} harmonic. Peak or average actuating devices are not acceptable. Current sensors shall be toroidal construction, encased in a plastic housing, filled with epoxy to

protect against damage and moisture and shall be integrally mounted on the breaker. Where indicated on the drawings, circuit breaker frames shall be rated for 100 percent continuous duty. Circuit breakers shall have tripping features as described below;

1. Long time current pick up.
2. Adjustable long time delay.
3. Short time current pick up.
4. Adjustable short time delay.
5. Short time I square times t switch.
6. Instantaneous current pick up.
7. Ground fault current pick up, adjustable from 20 percent to 60 percent of sensor rating, but in no case greater than 1200 amperes. Sensing of ground fault current at the main bonding jumper or ground strap shall not be permitted. Provide ground fault only where indicated on the drawings.
8. Overload and short circuit and ground fault trip indicators shall be provided.

J. Interrupting ratings shall be as indicated on drawings. Circuit breakers shall be fully rated for available fault current. Series rating is not acceptable.

K. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
4. Provide the following where noted on the drawings or schedules:

   a. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered for solid state type trip units and remote-mounted and powered for magnetic type trip units with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
   b. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

2.6 ARC-FLASH LIMITING CIRCUIT BREAKERS - ENERGY-REDUCING MAINTENANCE SWITCH (ERMS)

A. Provide on all breaker frames 1200 amps and higher independent of trip plug rating.

B. Circuit breakers shall be without current-limiting fuses, listed as complying with UL 1066.

C. Short-circuit withstand current rating shall be 200 kA.

D. Equip the arc-flash limiting feeder circuit breakers with Arc-Flash Maintenance Setting switch for use as a temporary arc-flash incident energy-reduction device during maintenance activities on that feeder.

1. Provide a manual switch on the compartment door to switch the circuit-breaker short-time tripping characteristics to instantaneous with minimum pickup setting, to reduce the danger from potential arc-flash at downstream equipment.
2. Provide a lock feature for the switch so that it may be locked in either the off or on maintenance-mode position.
3. Provide a blue LED indicating light to indicate that the switch is in maintenance mode.
4. Provide dry relay contacts on each switch for annunciation of the switch position.

2.7 ENCLOSURES

a. Indoor Dry and Clean Locations: Type 1.
b. Outdoor Locations: Type 3R.
c. Outdoor Locations subject to salt air: Type 4X, 316 stainless steel.
d. Kitchen and wash-down areas: Type 4X, 316 stainless steel.
e. Pool and Water Equipment room with salt water, chlorine, or chemical storage: Type 4X, 316 stainless steel.
f. Other Wet or Damp Indoor Locations: Type 4.
g. Hazardous Areas Indicated on Drawings: Type 9.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Comply with mounting and anchoring requirements for seismic installations.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Circuit breakers and molded case switches shall be factory installed in enclosures.

F. Comply with NECA 1.

G. Disconnect switches, located at motors controlled by an adjustable frequency drive shall be provided with a late make, early break auxiliary contact rated for ten amps continuous duty. This auxiliary contact shall be wired into the VFD emergency shutdown (coast to stop) circuit to ensure shutdown of the VFD in the event of the disconnect being opened.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

F. Test and/or permanently record the following:

1. Fuses:

a. Equipment nameplate requirement.
b. Actual fuse rating.

2. Circuit Breakers:

a. Nameplate data.
b. Actual trip setting.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section “System Studies.”

END OF SECTION

SECTION 26 31 11 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM (EXISTING SYSTEM)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 REFERENCE CODES AND LISTINGS

A. National Fire Protection Association (NFPA) – The latest adopted edition of the code referenced:

1. NFPA 1 – National Fire Code
2. NFPA 13 – Standard for the Installation of Sprinkler Systems
3. California Electrical Code (CEC)
4. NFPA 72 – National Fire Alarm Code
5. NFPA 90A – Standard for the Installation of Air Conditioning and Ventilating Systems
6. NFPA 101 – Life Safety Code

B. Federal Guidelines for Accessibility for Americans with Disabilities

C. ASME 17.1 Elevator Code

D. Current adopted Local and Stage Building Code(s).

E. Approval from the Office of the State Fire Marshal.

F. The system as a whole and the individual system components shall comply with applicable listings of Underwriter's Laboratories (UL), including but not limited to the following.

1. UL 864 - Control Units for Fire Protective Signaling Systems.
2. UL 268 (7th Edition) - Smoke Detectors for Fire Protective Signaling Systems.
3. UL 268A (7th Edition) - Smoke Detectors for Duct Applications.
4. UL 217 - Single and Multiple Station Smoke Alarms
5. UL 521 - Heat Detectors for Fire Protective Signaling Systems.
6. UL 228 - Door Closers-Holders, With or Without Integral Smoke Detectors.
7. UL 464 - Audible Signaling Appliances.
8. UL 38 - Manually Actuated Signaling Boxes for Use with Fire-Protective Signaling Systems
9. UL 346 - Waterflow Indicators for Fire Protective Signaling Systems.
10. UL 1971 - Signaling Devices for the Hearing-Impaired.

11. UL-1480 - Speakers for Fire Alarm, Emergency, and Commercial and Professional Use
12. UL 1481 - Power Supplies for Fire Protective Signaling Systems.
13. UL 1711 - Amplifiers for Fire Protective Signaling Systems.
14. UL 1635 - Digital Alarm Communicator System Units
15. UL-1638 - Signaling Appliances - Private Mode Emergency and General Utility Signaling

1.3 SUMMARY

A. Section Includes:

1. Existing fire alarm system to be modified
2. Manual fire alarm pull stations.
3. System smoke detectors.
4. Non-system smoke detectors (single station type).
5. Duct smoke detectors.
6. Projected beam smoke detectors.
7. Carbon monoxide detectors.
8. Heat detectors.
9. Air-sampling smoke detectors.
10. Fire Alarm notification appliances.
11. Magnetic door holders.
12. Remote annunciator.
13. Air handling system shutdown relays
14. Fire Alarm Addressable interface devices
15. Water flow detector pressure switches
16. Sprinkler supervisory switches
17. Device guards

B. Related Sections include the following:

1. Division 26 Section “Low-Voltage Electrical Power Conductors and Cables”
2. Division 26 Section “Grounding and Bonding for Electrical Systems”
3. Division 26 Section “Raceways and Boxes for Electrical Systems”
4. Division 26 Section "Seismic Restraint For Electrical Systems" for requirements necessary for compliance with seismic criteria.

1.4 DEFINITIONS

A. LED: Light-emitting diode.

B. NICET: National Institute for Certification in Engineering Technologies.

1.5 SYSTEM DESCRIPTION

A. The existing addressable fire alarm system shall be extended as indicated on the drawings and described herein. The existing fire alarm system is **Edwards**.

B. Contractor shall verify adequacy of system battery and power supply capacity to serve new system devices. Contractor shall provide additional battery and power supply capacity, if required, to support new devices being added to system.

C. New devices shall be connected to existing system such that existing function and operation of system is maintained.

D. Where visual alarm notification appliances (strobes) are added in an area and there are more than two visual signal devices in field of view, all visual signal devices within field of view (new and existing) shall be synchronized. Contractor shall replace existing strobes and provide the necessary modules in the control unit where necessary to accomplish synchronization.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.

1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
2. Include voltage drop calculations for notification appliance circuits.
3. Include 25% spare capacity on each signal circuit so that additional devices can be added.
4. Include substantiating emergency (battery) and normal power supply calculations for supervisory and alarm power requirements and calculations of notification appliance circuit loading (end of circuit voltage drop) to ensure proper operation of all devices.
5. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
6. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits. Drawing scale shall match engineers design drawings.
7. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
8. Include complete schematic circuit diagrams for system, including all equipment. Wiring diagram shall show point to point connections between all system components

9. Include descriptions of system operation, annunciator schedule showing titles for each zone, and manufacturer's literature marked to show model and catalog number for all equipment.
10. Include complete riser diagrams for system indicating wiring sequence of all alarm devices and control equipment shall be included with submittal data.
11. Show field wiring and equipment required for HVAC unit shutdown on.

C. General Submittal Requirements:

1. Shop Drawings shall be prepared by persons with the following qualifications:

a. Trained and certified by manufacturer in fire-alarm system design.
b. NICET-certified fire-alarm technician, Level III minimum.

D. Permit Drawings:

1. The System's Contractor shall prepare fire alarm system installation drawings for permitting in accordance with Florida Administrative Code Rule 61G15. Drawings shall incorporate all required information per Rule 61G15 and be signed and sealed by a registered professional engineer meeting the requirements of Rule 61G15. The System's Contractor furnishing and installing the fire alarm system is responsible for preparation of these drawings and getting drawings approved by the Authority Having Jurisdiction (AHJ).

E. Systems Contractor Qualifications.

1. The contractor directly responsible for this work shall be a systems contractor, who is and who has been regularly engaged in the furnishing and installation of commercial and industrial fire alarm systems of this type and size for at least the immediate past 5 years. All equipment shall be installed by a technician trained by the equipment manufacturer or a recognized training school or course for the installations of this type system. The contractor shall, if requested by the engineer, show proof of a specific individual's training. The system's contractor shall directly employ a suitable number of skilled systems installers whose normal work is systems installation and who shall install and make the wire and cable connections thereto.
2. As part of the project submittal, it shall be demonstrated to the satisfaction of the engineer that the systems contractor has adequate plant and equipment to do the work properly and expeditiously, adequate staff and technical experience.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Seismic Qualification: Manufacturer's certification of seismic qualification according to ASCE 7. Submit ASCE 7 special seismic certification as required. Include method used to determine compliance with requirements.

1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
3. Record copy of site-specific software.
4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:

   a. Frequency of testing of installed components.
   b. Frequency of inspection of installed components.
   c. Requirements and recommendations related to results of maintenance.
   d. Manufacturer's user training manuals.

5. Manufacturer's required maintenance related to system warranty requirements.
6. Abbreviated operating instructions for mounting at fire-alarm control unit.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

C. The Contractor shall provide three bound copies of the following, to be forwarded to the Owner at completion of project:

1. As-built wiring and conduit layout diagrams showing all fire alarm devices on floor plans, including wire color code and terminal numbers, and showing all interconnections in the system.
2. Electronic circuit diagrams of all FACP modules, power supplies, annunciator, data gathering panels, addressable interface modules, etc.

3. Technical literature on all major parts of the system, including control panels, smoke detectors, batteries, manual stations, alarm notification appliances, power supplies, and remote alarm transmission means.

1.9 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than 1 unit of each type.
2. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but no fewer than 1 unit of each type.
3. Keys and Tools: One extra set for access to locked and tamperproofed components.
4. Audible and Visual Notification Appliances: Three of each type installed.
5. Fuses: Two of each type installed in the system.

1.10 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. The addressable fire alarm system shall be connected, programmed, and tested only by the manufacturer or by an authorized distributor who stocks a full compliment of spare parts for the system. Technicians performing this service shall be trained and individually certified by the manufacturer for the model of system being installed. Copies of their certifications must be included with the contractor's submittal to the engineer, prior to installation. The submittal cannot be approved without this information.

C. System equipment shall be from a single manufacturer and shall be supported by a manufacturer authorized, established service organization that shall stock parts for the equipment supplied. Components shall be compatible with, and operate as, an extension of the existing fire alarm system.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Licensed or certified by authorities having jurisdiction.

F. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II technician.

1.11 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Receive equipment at jobsite; verify applicable components and quantity delivered per invoice.

B. Handle equipment to prevent internal components damage, breakage, denting, and scoring enclosure and finish.

C. Do not install damaged equipment.

D. Store equipment in a clean, dry space and protect from dirt, fumes, water, construction debris, and physical damage.

E. After installation, protect from damage by work of other trades.

1.12 PROJECT CONDITIONS

A. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of fire-alarm service.
2. Do not proceed with interruption of fire-alarm service without Owner's written permission.

1.13 SEQUENCING AND SCHEDULING

A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.

B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.14 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning with Substantial Completion, provide software support for two years.

C. Upgrade Service:

1. Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

2. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.15 WARRANTY

A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of system and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Manufacturer’s standard warranty period (minimum one year) from date of start-up.
2. Labor and travel time for necessary repairs at the job site shall be included.

PART 2 - PRODUCTS

2.1 EXISTING FIRE-ALARM SYSTEM TO BE MODIFIED

A. Basis for Pricing: Edwards

B. Source Limitations for Fire-Alarm System and Components: Components must be compatible with, and operate as extension of, existing system. Provide system manufacturer's certification that components provided have been tested as, and will operate as, a system.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:

1. Manual fire alarm pull stations.
2. Heat detectors.
3. Smoke detectors.
4. Duct smoke detectors.
5. Air-sampling smoke-detection system.
6. Carbon monoxide detectors.
7. Preaction (dry pipe) system.
8. Automatic sprinkler system water flow.
9. Fire-extinguishing system operation.
10. Fire standpipe system.
11. Kitchen hood fire suppression system
.

B. Fire-alarm signal shall initiate the following actions: (For a full list of system inputs and outputs and associated responses, refer to the Fire Alarm Matrix and Smoke Control Fire Alarm Matrix on the drawings)

1. Continuously operate alarm notification appliances.

2. Identify alarm at fire-alarm control panel and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.
6. Activate voice/alarm communication system.
7. Activate smoke-control system (smoke management) at firefighter smoke-control system panel.
8. Activate stairwell and elevator-shaft pressurization systems.
9. Signal Automatic Load Control Relays (ALCRs) and emergency lighting control/dimming panels to override switched/controlled emergency luminaires.
10. Close smoke dampers in air ducts of designated air-conditioning duct systems.
11. Recall elevators to primary or alternate recall floors (certain conditions apply).
12. Activate emergency shutoffs for gas and fuel supplies.
13. Record events in the system memory.
14. Record events by the system printer.
15. If fire alarm activation is caused by any smoke detector, duct detector, sprinkler flow alarm switch, or other automatic detection device located on or serving a floor, the following actions shall be initiated:

    a. Shut down all air handling systems and exhaust fans serving that floor.
    b. Close all smoke dampers in ducts associated with the air handling unit along with exhaust fans that are shut down.
    c. Surgery Suite smoke compartment air handling system shall only shut down upon activation of the fire alarm system by any smoke detector, duct detector, sprinkler flow alarm switch or other automatic detection device within or serving the Surgery Suite smoke compartment.

C. Supervisory signal initiation shall be by one or more of the following devices and actions: (For a full list of system inputs and outputs and associated responses, refer to the Fire Alarm Matrix and Smoke Control Fire Alarm Matrix on the drawings)

1. Valve supervisory switch.
2. Sprinkler tamper switches.
3. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
4. Elevator shunt-trip supervision.
5. Opening of building key box.
6. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system.
7. Abnormal position of any switch (ie bypass) at fire-alarm control panel or annunciator.
8. Provide monitoring of the following fire pump alarms:

    a. Pump running.
    b. Controller connected to alternate power source.
    c. Phase loss, phase reversal

D. System trouble signal initiation shall be by one or more of the following devices and actions: (For a full list of system inputs and outputs and associated responses, refer to the Fire Alarm Matrix and Smoke Control Fire Alarm Matrix on the drawings)

1. Open circuits, shorts, and grounds in designated circuits.
2. Loss of primary power at fire-alarm control panel.
3. Ground or a single break in fire-alarm control panel internal circuits.
4. Abnormal ac voltage at fire-alarm control panel.
5. Break in standby battery circuitry.
6. Failure of battery charging.

E. Kitchen Hood Operation:

1. Activation of the kitchen hood extinguishing system shall shut off gas and electrical power to all equipment requiring protection by the extinguishing system and send alarm signal to fire alarm control panel and remote annunciator(s) indicating "HOOD SUPPRESSION SYSTEM". Hood exhaust fan(s) shall continue to operate after the extinguishing system has been activated, unless fan shutdown is required by a listed component of the ventilation system or by the design of the extinguishing system. It is not required to restart the hood exhaust fan(s) when the extinguishing system is activated if the exhaust fan(s) and all cooking equipment served by the fan had previously been shut down. When its fire extinguishing system discharges, make-up air supplied internally to the hood shall be shut off.
2. Hood extinguishing system activation shall perform all fire alarm functions as any other automatic detection device in the system.
3. Activation of an automatic detection device in the smoke compartment zone in which the hood is located or in an adjacent smoke compartment zone shall cause the hood exhaust and supply fan(s) to shut down. Gas and electric power to equipment under hood shall be shut off.

F. Doctor’s sleeping rooms system type smoke detectors shall be displayed individually at the fire alarm control panel and remote annunciator. Activation of a smoke detector in a Doctor’s sleeping room sound the general alarm and shall sound an audible alarm within the sleeping room at all audible detector bases. Provide 520 Hz sounder base for all sleeping room smoke detectors.

1. Interconnected rooms in suites or adjacent rooms with a connecting door shall have their sounder bases interconnected.

G. Automatic Lighting Control Relays (ALCRs).

1. Upon activation of notification appliances, ALCRs shall receive a signal from the fire alarm control panel to override any switched and/or controlled emergency luminaires so that the fixtures are illuminated regardless the switched position.

H. Elevator Control.

1. Upon activation of elevator lobby, hoistway or machine room smoke detector, phase 1 elevator recall shall be initiated.
2. Upon activation of heat detector(s) in elevator hoistway or machine room, power to the elevator(s) shall be disconnected prior to the application of water. Phase I recall shall meet all requirements of the adopted version ASME A17.1 Safety Code for Elevators.

I. System installation shall allow remote restarting of all air handling systems after having been shut down by the Fire Alarm System. Air handling systems shall automatically restart after fire alarm system has been reset.

J. Smoke dampers in ducts shall close whenever associated air handling system is shut down either by fire alarm system activation or otherwise.

2.3 FIRE-ALARM CONTROL PANEL (FACP) – EXISTING TO BE MODIFIED

A. Circuits:

1. Initiating Device Circuits: NFPA 72, Class B.
2. Notification Appliance Circuits: NFPA 72, Class B.
3. Signaling Line Circuits: NFPA 72, Class B.
4. Network Circuits: NFPA 72, Class A.
5. Provide 25% spare capacity on circuits for additional devices.

B. Pathway Survivability – Initiating Device, Notification Appliances and Signaling Line Circuits:

1. Voice Evacuation Type Systems: for all notification and communications circuits and other circuits necessary to ensure the continued operation of the emergency communications system shall be NFPA 72, Pathway Survivability Level 2 or 3 utilizing 2-hour fire rated circuit integrity (CI) cable or other NFPA 72 and AHJ approved method.

   a. All circuits necessary for the operation of the notification appliances shall be protected until they enter the evacuation signaling zone that they serve per NFPA 72. Once in evacuation signaling zone then Pathway Survivability Level 1 (EMT Conduit).

C. Stairwell Pressurization and/or Elevator Shaft: Provide an output signal using an addressable relay to start the stairwell and/or elevator shaft pressurization system. Signal shall remain on until alarm conditions are cleared, and fire-alarm system is reset. Signal shall not stop in response to alarm acknowledge or signal silence commands.

1. Pressurization starts when any alarm is received at FACP.
2. Alarm signals from smoke detectors at pressurization air supplies have a higher priority than other alarm signals that start the system.

D. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory and print out the final adjusted values on system printer.

E. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

F. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided in a separate cabinet located at the fire alarm control panel.

1. Indicated number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711 and be listed by an NRTL.

    a. Allow the application of and evacuation signal to indicated number of zones and, at same time, allow voice paging to the other zones selectively or in any combination.
    b. Programmable tone and message sequence selection.
    c. Standard digitally recorded messages for "Evacuation" and "All Clear."
    d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification appliance circuits of FACP.

2. Provide separate paging zones for stairwells, elevator lobbies and other areas as required by code.
3. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
4. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.
5. Provide sufficient amplification to operate all system speakers simultaneously plus thirty (30) percent spare capacity. Calculation shall assume each speaker is connected at the one (1) watt tap.

G. Power Supplies:

1. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.

    a. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

2. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

   a. Batteries: Sealed lead calcium.

3. After 24 hours, the battery backup supply shall be capable of energizing all signal devices for a period of at least fifteen minutes. In addition, the low battery backup supply monitor shall supervise and automatically sound System Trouble in the event that a trouble occurs in the system (i.e., the batteries being disconnected or discharging to 85% of full charge). Battery and power supply capacity shall provide an additional 25% spare capacity for additional alarm signal devices that may be added to the system.
4. Provide power supply and battery capacity for system operation. Power supply and battery capacity shall be sized to allow an additional 25% spare capacity for future growth. The power supply shall be able to perform an automatic load test of batteries and indicate a trouble condition if the batteries fall outside a predetermined range. Power supplies shall incorporate the ability to adjust the charge rate of batteries based on ambient temperatures. Exact locations and quantities of power supplies shall be as determined by the contractor.

H. Surge Protection Devices

1. The system shall be provided with the following protective devices to prevent damage of nuisance alarms by nearby lightning strikes, stray currents, or voltage transients. They are to be provided by the fire alarm equipment supplier:

   a. On AC Input: Ditek DTK-120HW or DTK-120/240 CM or equal UL Listed device approved by NCDoI. Installed at the electrical panelboard, and trim excess lead lengths. Wind small coil in the branch circuit conductor just downstream of the suppressor connection. Coil to be 5 to 10 turns of about 1" diameter, and tie-wrapped.
   b. On DC circuits Extending Outside Building: Adjacent to the FACP, and near the point of entry to the outlying building, provide a “pi” filter on each leg. This consists of a primary arrestor, a series impedance of 1 millihenry or more, and a fast acting secondary arrestor which clamps between 30 and 40 volts. Acceptable models with these or equivalent features include Simplex 2081-9027 and 2081-9028, Transtector TSP8601, Ditek DTKxLVL series, Citel American B280 -24V, Edco P264 and P642, or equal. Submit specification on other candidate suppressors for approval.

I. Networking

1. Provide required fiber network modules and equipment to network multiple Fire Alarm Control Panels in remote buildings.
2. All cable between buildings Fire Alarm Control Panels shall be multimode optical fiber cable in approved raceway system. All fire alarm “backbone cable” shall be 50/125 laser optimized multimode optical fiber suitable for in-ground applications (indoor/outdoor rated). Provide quantity as required by manufacturer.

2.4 MANUAL FIRE ALARM PULL STATIONS

A. General Requirements for Manual Fire-Alarm Pull Stations: Comply with UL 38.

B. Pull Stations shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to FACP.
2. Station Reset: Key- or wrench-operated switch.
3. Weatherproof Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Provide for any devices located outdoors.

2.5 SYSTEM SMOKE DETECTORS

A. Photoelectric Smoke Detectors:

1. Comply with UL 268 7th Edition and NFPA 72; operating at 24-V dc, nominal.
2. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
3. Provide Black detectors in ceiling areas that are blacked out and where noted on plans.
4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
5. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status. LED status light not to be programmed to show power on status in all sleeping rooms (ie no flashing status light in any sleeping room.
6. Detector address must be accessible from FACP and must be able to identify detector's location within system and its sensitivity setting.
7. Detector must have functional humidity range within 10 to 90 percent relative humidity.
8. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control panel for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control panel.
9. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control panel for 15 or 20 deg F per minute.
10. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control panel to operate at 135 or 155 deg F.
11. Multiple levels of detection sensitivity for each sensor.
12. Sensitivity levels based on time of day.

13. An operator at fire-alarm control panel, having the designated access level, shall be able to manually access the following for each detector:

    a. Primary status.
    b. Device type.
    c. Present average value.
    d. Present sensitivity selected.
    e. Sensor range (normal, dirty, etc.).

B. Duct Smoke Detectors:

1. Photoelectric type complying with UL 268A (7th Edition) and NFPA 72.

    a. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACP.
    b. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
    c. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
    d. Detector address must be accessible from FACP and must be able to identify detector's location within system and its sensitivity setting.
    e. Operator at FACP, having designated access level, must be able to manually access the following for each detector:

        1) Primary status.
        2) Device type.
        3) Present average value.
        4) Present sensitivity selected.
        5) Sensor range (normal, dirty, etc.).

    f. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with supplied detector for smoke detection in HVAC system ducts.
    g. Each sensor must have multiple levels of detection sensitivity.
    h. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.

2.6 INTELLIGENT ADDRESSABLE HEAT DETECTORS

A. General Requirements for Heat Detectors: Comply with UL 521 and NFPA 72.

B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.

1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control panel.
3. Detector must have functional humidity range of 10 to 90 percent relative humidity.
4. Auxiliary contacts rated for 120 volts AC for control of elevator shunt trip breaker.

C. Heat Detector – Dual Reporting, Fixed Temperature Type (Fire Service Elevator Lobbies and Associated Elevator Control Rooms):

1. Provide intelligent dual reporting fixed temperature heat detectors. Provide a fixed 135 deg F Alarm threshold plus a separate programmable Emergency threshold: Fixed temperature reporting generates an Alarm condition when the device's 135 deg F is reached; Emergency reporting can be used to report elevated temperatures in evacuation elevator lobbies and machine rooms.
2. Detectors shall report back to a dedicated "Fire Service Access Elevator Status Annunciator Panel" located in the Fire Command Center that uniquely identifies each fire service elevator lobby temperature thresholds in accordance with NFPA 72, Chapter 21.

2.7 CARBON MONOXIDE DETECTORS

A. Description: Carbon monoxide detector listed for connection to fire-alarm system.

B. General Requirements for Carbon Monoxide Detectors: Comply with NFPA 720, NFPA 72, and UL 2075.

1. Mounting: Adapter plate for outlet box mounting.
2. Testable by introducing test carbon monoxide into sensing cell.
3. Detector must provide alarm contacts and trouble contacts.
4. Detector must send supervisory alarm when nearing end-of-life, power supply problems, or internal faults.
5. Locate, mount, and wire in accordance with manufacturer's written instructions.
6. Provide means for addressable connection to fire-alarm system.
7. Test button simulates alarm condition.
8. Provide integral sounder base that alarms on detection.

2.8 FIRE-ALARM NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, equipped for mounting as indicated and with screw terminals for system connections.

1. Device Color: Factory finished, red.
2. Devices shall be flush mounted with surface.
3. Strobes shall be set at 75 candela, unless otherwise noted on drawings.
4. Exterior mounted devices shall be provided with flush mounted weatherproof backbox.

B. Visible Notification Appliances: LED strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.

1. Rated Light Output:

a. Wall mounted - 15/30/75/110 cd, field selectable and synchronized.
b. Ceiling mounted - 15/30/75/95/115 cd, field selectable and synchronized.

1) If higher candela ratings are indicated on drawings and not available in LED versions, then Xeon type is acceptable for only those units.

2. Mounting: Wall mounted unless otherwise indicated.
3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
4. Flashing shall be in a temporal pattern, synchronized with other units.
5. Strobe Leads: Factory connected to screw terminals.

C. Chimes: Low-Level Output: Vibrating type, 75-dBA minimum rated output. High-Level Output: Vibrating type, 81-dBA minimum rated output.

D. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.

1. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.

E. Pole mounted devices shall be flush mounted in pole at 88” to center of device.

1. Pole: Aluminum, 6” Square, 96” high

a. Hapco Cat# SSA08D6-4
b. Standard power coat finish color selected by Architect.
c. Provide flush 4” backbox recessed in pole at required mounting height.

2.9 FIREFIGHTERS' TWO-WAY TELEPHONE COMMUNICATION SERVICE

A. Dedicated, two-way, supervised, telephone voice communication links between fire-alarm control panel, the fire command center, and remote firefighters' telephone stations. Supervised telephone lines shall be connected to talk circuits by controls in a control module. Provide the following:

1. Common-talk type / Selective-talk as required by fire department.
2. Controls to disconnect phones from talk circuits if too many phones are in use simultaneously.
3. Audible Pulse and Tone Generator, and High-Intensity Lamp: When a remote telephone is activated, it causes audible signal to sound and high-intensity lamp to flash at FACP.
4. Selector panel controls shall provide for simultaneous operation of up to six telephones in selected zones. Indicate ground faults and open or shorted telephone lines on the panel front by individual LEDs.
5. Display: Liquid-crystal digital to indicate location of caller.
6. Remote Telephone Cabinet: Flush- or surface-mounted cabinet as indicated, factory-standard red finish, with handset.

a. Install one-piece handset to cabinet with vandal-resistant armored cord. Silk-screened or engraved label on cabinet door, designating "Fire Emergency Phone."
b. With "break-glass" type door access lock.

7. Remote Telephone Jack Stations: Single-gang, stainless-steel-plate mounted plug, engraved "Fire Emergency Phone."
8. Handsets: push-to-talk-type sets with noise-canceling microphone stored in a cabinet adjacent to fire-alarm control panel in the fire command center.

2.10 FIREFIGHTERS' SMOKE-CONTROL SYSTEM

A. Refer to Smoke Control System Fire Alarm Matrix and additional control panel and schematic on drawings for additional information.

B. Initiate Smoke-Management Sequence of Operation:

1. Comply with sequence of operation as described in control matrix on drawings.
2. Fire-alarm system shall provide all interfaces and control points required to properly activate smoke-management systems.
3. First fire-alarm system initiating device to go into alarm condition shall activate the smoke-control functions.
4. Subsequent devices going into alarm condition shall have no effect on the smoke-control mode.

C. Addressable Relay Modules:

1. Provide address-setting means on the module. Store an internal identifying code for control panel use to identify the module type.
2. Allow the control panel to switch the relay contacts on command.
3. Have a minimum of two normally open and two normally closed contacts available for field wiring.

2.11 FIRE-ALARM SPRINKLER VALVE AND FLOW GRAPHIC ANNUNCIATORS

A. Regulatory Requirements: NFPA 72 and NFPA 101.

B. Provide in Fire Command Center (FCC) in accordance with NFPA 101 and local fire department.

C. General Characteristics:

1. Graphic Annunciator Panel: Mounted in aluminum frame with nonglare, minimum 3/16 inch thick, clear acrylic cover over graphic representation of building sprinkler valves tamper and flow switches. Device locations must be represented by red LED lamps. Normal system operation must be indicated by lighted, green LED. Trouble and supervisory alarms must be represented by amber LED.

a. Comply with UL 864.
b. Operating voltage must be 24 V(dc) provided by local 24 V power supply provided with annunciator.
c. Include built-in voltage regulation, reverse polarity protection, RS 232/422 serial communications, and lamp test switch.
d. Semiflush mounted in NEMA 250, Type 1 cabinet, with key lock and no exposed screws or hinges.
e. LED representing detector must flash two times per second while detector is in alarm.

2.12 POWER SUPERVISORY RELAY

A. Provide power supervisory relay modules as required. The relay shall provide one form "C" output for closing or opening circuit on activation. Relay shall be heavy duty rated at 7 amps @ 24 Vdc. A red LED shall be provided to indicate that the relay is energized. Relays shall be flush wall mounted (end of circuit) within junction box behind area pull station or smoke detector.

2.13 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.

1. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
3. All holders shall be normally be energized, and a release shall be accomplished by interrupting the circuit.
4. Rating: 24-V dc.

B. Material and Finish: Match door hardware.

2.14 FIRE ALARM REMOTE ANNUNCIATORS

A. Annunciator functions shall match those of fire-alarm control panel for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control panel, including acknowledging, silencing, resetting, and testing.

1. Mounting: Flush cabinet, NEMA 250, Type 1.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control panel. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

C. Voice evacuation type system's remote annunciator shall also have microphone.

2.15 FIRE ALARM ADDRESSABLE INTERFACE DEVICES

A. General Characteristics:

1. Include address-setting means on module.
2. Store internal identifying code for control panel use to identify module type.
3. Listed for controlling HVAC fan motor controllers.
4. Monitor Module: Microelectronic module providing system address for alarm-initiating devices for wired applications with normally open contacts.

B. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall and/or to circuit-breaker shunt trip for power shutdown.

C. Air Handling System Shutdown Relays: Provide and install a supervised addressable output relay at each Air Handling System for shutdown on alarm from fire alarm system as per system operation description. The unit shall be normally closed with a coil to match voltage of Fire Alarm Control Panel and interrupt starting circuit of Air Handling System unit fan(s). Provide and install a supervised addressable output relay at each exhaust fan for shutdown on alarm from fire alarm system as per system operation description, unless exhaust fan is interlocked with AHU.

D. Waterflow Detector/Pressure Switches: Waterflow or pressure switches to be supplied and installed by the fire protection system contractor and wired to the Fire Alarm System by this Contractor. Provide addressable water flow/tamper module for each switch so that each switch can be individually monitored.

2.16 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control panel and automatically capture telephone line and dial a preset number for a remote central station (in addition provide second backup source in accordance with NFPA 72). When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on telephone line or backup source, transmitter shall initiate the local trouble signal.

C. Local functions and display at the digital alarm communicator transmitter shall include the following:

1. Verification that telephone is available.
2. Programming device.
3. LED display.
4. Manual test report function and manual transmission clear indication.

5. Communications failure with the central station or fire-alarm control panel.

D. Digital data transmission shall include the following:

1. Address of the alarm-initiating device.
2. Address and/or Zone of the supervisory signal.
3. Address and/or Zone of the trouble-initiating device.
4. Loss of ac supply or loss of power.
5. Low battery.
6. Abnormal test signal.
7. Communication bus failure.

E. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.17 FIRE SERVICE ACCESS ELEVATOR STATUS PANEL

A. Provide dedicated annunciator panel located in the Fire Command Center (FCC) that individually annunciates the statuses below for each Fire Service Access Elevator Lobby by individual floor as well as associated Elevator Machine/Control Room.

1. Elevator Lobby Smoke Detector in Alarm
2. Elevator Control Room Smoke Detector in Alarm
3. Temperature Normal < 90 Degrees F
4. Monitoring Temperature 90 Degrees F to 135 Degrees F
5. Unsafe Temperature > 135 Degrees F

B. Provide switch to turn on Fire Service Elevator Hoistway lights integrated into panel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Preinstallation Testing: Perform verification of functionality of installed components of existing system prior to starting work. Document equipment or components not functioning as designed.

B. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service in accordance with requirements indicated:

1. Notify Owner no fewer than seven days in advance of proposed interruption of fire-alarm service.
2. Do not proceed with interruption of fire-alarm service without Owner's written permission.

C. Protection of In-Place Conditions: Protect devices during construction unless devices are placed in service to protect facility during construction.

3.3 INSTALLATION OF EQUIPMENT

A. Comply with NECA 305, NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

1. Devices placed in service before other trades have completed cleanup must be replaced.
2. Devices installed, but not yet placed, in service must be protected from construction dust, debris, dirt, moisture, and damage in accordance with manufacturer's written storage instructions.

B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.

1. Connect new equipment to existing control unit in existing part of the building.
2. Connect new equipment to existing monitoring equipment at the supervising station.
3. Expand, modify, and supplement existing control and monitoring equipment as necessary to extend existing control and monitoring functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

C. No wiring other than that directly associated with fire alarm or auxiliary fire protection functions shall be permitted in fire alarm conduits. There shall be NO splices in the system other than at terminal blocks. “Wire nuts” and crimp splices are NOT permitted. Permanent wire markers shall be used to identify all terminations for each circuit. For splices, use markers or other means to indicate which conductor leads to the FACP. All

connections shall be made on terminal strips. All terminal block screws shall have pressure wire connectors of the self-lifting or box lug type. No more than two conductors under one connection. Wire on these terminals shall be labeled. Transposing or changing color coding of wires shall not be permitted. All conductors in conduit containing more than one wire shall be labeled on each end with "E-Z markers" or equivalent. Conductors in cabinets shall be carefully formed and harnessed so that each drops off directly opposite to its terminal. Cabinet terminals shall be numbered and coded. All controls, function switches, etc., shall be clearly labeled on all equipment panels. All wiring shall be checked and tested to ensure that there are no grounds, opens or shorts.

D. All wiring shall be color coded in accordance with the following scheme, which shall be maintained throughout the system, without color change in any wire run:

1. Initiating Circuits Yellow(+)/Brown (-)
2. Alarm Indicating Appliance Circuits Red(+)/Blue (-)
3. AHU Shutdown Circuits Orange
4. Door Control Circuits Gray
5. Elevator Capture Circuits Violet
6. Exception: Addressable initiating circuits shall comply with Paragraph below.

E. Wire shall be 14 AWG minimum, stranded or solid copper, type THHN or THWN except for addressable loop controller circuits. Addressable loop controller circuits are to be wired with type FPL/FPLR/FPLP fire alarm cable, solid copper, AWG 18 minimum, twisted pair, installed in conduit, instead of AWG 14 THHN/THWN stranded conductors. Provide shielded cable if required by manufacturer. If shielded cable is required by manufacturer, cable shield drain wires are to be connected at each device on the loop to maintain continuity, and taped to insulate from ground. Terminate the shield at the FACP in accordance with the manufacturer's instructions. The cable shall have red jacket, with yellow (+) and brown(-) conductors.

F. Riser cable for alarm signaling circuits shall be a 2-hour rated cable.

G. All addressable loop controller circuits shall have a minimum of 25% spare addresses for future use. "T" taps from the loop are permitted, but only if they serve no more than 30 initiating devices and/or control points, in an area which does not exceed approximately half of one story. To minimize the impact of a wiring fault on the system, isolation modules must be provided as follows:

1. After each 30 devices/control points on any addressable circuit, including taps.
2. At each "T" tap which feeds 5 or more devices/control points.
3. For each circuit extending outside the building.
4. All isolation modules must be clearly labeled, readily accessible for convenient inspection, and shown on the as-builts.

H. Initiating device or indicating appliance circuits must not be included in raceways containing AC power or AC control wiring. Within the FACP panel, any AC control wiring must be properly separated from other circuits. The enclosure must have an appropriate warning label to alert service personnel to the hazard.

I. A unique identification number shall be assigned to each initiating device. (Identification shall be by zone number and device number within the zone.) This number shall be noted on the submittals and as-built plans, and also be permanently mounted adjacent to the detector or affixed to its base.

J. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor.

K. Comply with mounting and anchoring requirements for seismic installations.

L. Smoke- or Heat-Detector Spacing:

1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
3. Smooth ceiling spacing shall not exceed [**30 feet**].
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A or Appendix B in NFPA 72.
5. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture.

M. Install cover on each smoke detector that is not placed in service during construction. Cover must remain in place except during system testing. Remove cover prior to system turnover.

N. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend full width of duct. Tubes more than 36 inch long must be supported at both ends.

1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.
2. Provide weatherproof enclosures for any duct smoke detector installed outdoors.

O. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.

P. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

Q. Annunciator: Install with top of panel not more than 46 inches above the finished floor.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Division Section "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate must be laminated acrylic or melamine plastic signs, as specified in Division 26 Section "Identification for Electrical Systems."

E. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section "Door Hardware." Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.

F. Make addressable connections with a supervised interface device to the following devices and systems (Refer to the Fire Alarm Matrix **[and Smoke Control Fire Alarm Matrix**] for complete and comprehensive list of monitoring inputs and control outputs required by the contractor). Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Alarm-initiating connection to smoke-control system (smoke management) at firefighter smoke-control system panel.
2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
3. Smoke dampers in air ducts of designated air-conditioning duct systems.
4. Alarm-initiating connection to elevator recall system and components.
5. Alarm-initiating connection to activate emergency lighting control.
6. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
7. Supervisory connections at valve supervisory switches.
8. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
9. Supervisory connections at elevator shunt trip breaker.
10. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
11. Supervisory connections at fire-pump engine control panel.

3.5 PATHWAYS

A. All wiring shall be installed in EMT conduit. Flexible connections from above ceiling junction box to device shall be used for all devices mounted in suspended lay-in ceiling panels. All conduit, mounting boxes, junction boxes and panels shall be securely hung and fastened with appropriate fittings to insure positive grounding throughout the entire system.

1. Maintain pathway survivability requirements noted in this specification.

3.6 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Install framed instructions in a location visible from fire-alarm control panel.

3.7 POWER CONNECTIONS

A. Provide 120 volt, 20 amp circuit to all fire alarm panels, remote panels, terminal cabinets, etc (whether shown on drawings or not). Connect to spare 20 amp, 1 pole circuit breaker in nearest **Critical** 120 volt panel. Re-label circuit breaker accordingly. Provide lock-on device on breaker and color breaker red for all NFPA 72 systems.

3.8 GROUNDING

A. Ground FACP and associated circuits in accordance with Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Ground shielded cables at control panel location only. Insulate shield at device location.

3.9 FIELD QUALITY CONTROL

A. Administrant for Tests and Inspections:

1. Administer and perform tests and inspections with assistance of factory-authorized service representative.

B. Tests and Inspections:

1. Visual Inspection: Conduct visual inspection prior to testing.

a. Inspection must be based on completed record Drawings and system documentation that is required by "Completion Documents, Preparation" table in "Documentation" section of "Fundamentals" chapter in NFPA 72.

b. Comply with "Visual Inspection Frequencies" table in "Inspection" section of "Inspection, Testing and Maintenance" chapter in NFPA 72; retain "Initial/Reacceptance" column and list only installed components.

2. System Testing: Comply with "Test Methods" table in "Testing" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Test audible appliances for public operating mode in accordance with manufacturer's written instructions. Perform test using portable sound-level meter complying with Type 2 requirements in ASA S1.4 Part 1/IEC 61672-1.
4. Test audible appliances for private operating mode in accordance with manufacturer's written instructions.
5. Test visible appliances for public operating mode in accordance with manufacturer's written instructions.
6. Factory-authorized service representative must prepare "Fire Alarm System Record of Completion" in "Documentation" section of "Fundamentals" chapter in NFPA 72 and "Inspection and Testing Form" in "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.

C. Reacceptance Testing: Perform reacceptance testing to verify proper operation of added or replaced devices and appliances.

D. Fire-alarm system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION

SECTION 26 43 13 – SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes Surge Protective Devices SPDs for normal and emergency low-voltage (120 to 600 V) power equipment.

1.3 DEFINITIONS

A. SPD: Surge Protective Device(s), both singular and plural.

B. NTRL: Nationally Recognized Testing Lab

C. PER PHASE: Per Phase ratings are determined by multiplying the kA per mode times the number of discrete modes of protection (directly connected mov's), minus the value for the Neutral to ground mode, divided by the number of phases.

1. Wye or Split Phase Configured SPDs Per Phase Surge Current Capacity = (kA per mode X # of modes) minus the N-G mode / # of phases.
2. Delta Configured SPDs Per Phase Surge Current Capacity = (kA per mode) X (# 0f modes) / # of phases.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating weights, electrical characteristics, furnished specialties, and accessories.

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: For surge protective devices, signed by product manufacturer certifying compliance with the following standards:

1. UL 1283.
2. UL 1449 Current Edition listed.

B. Provide submittals for all required testing and pertinent manufacturer information described herein.

C. Surge suppression submittals shall include, but shall not be limited to the following items:

1. Complete wiring information for ALL SPD units indicating part numbers, conductor sizes, etc.
2. Submit installation details for all SPD units indicating mechanical and electrical connections to equipment being protected.
3. Manufacturer shall include their UL 1449 Current Edition and UL 1283 listing summaries showing the following information:

   a. UL 1449 Current Edition and UL 1283
   b. Short Circuit Current Rating (SCCR)
   c. Voltage Protection Ratings (VPRs) for all modes
   d. Maximum Continuous Operating Voltage rating (MCOV)
   e. I-nominal rating (I-n)
   f. SPD shall be UL 1449 4th Edition as a Type 2 Component or Listed Assembly. When connected to supply or utility side of service SPD shall be labeled as Type 1.

4. Documentation from manufacturer stating SPD incorporates all mode protection (i.e. line-to-neutral, line-to-line, line-to-ground, neutral-to-ground) "Reduced-Mode" variations will not be accepted.
5. Warranty certificate from manufacturer indicating the warranty duration and replacement policy.
6. Provide a table indicating which panel/switchboard/equipment each SPD unit will serve. Table shall include panel name, voltage/phase, and SPD model number to be provided.

Panel/Switchboard Name	Volts, Phase – 3Wire or 4 Wire	SPD Model Number

D. Test Reports: IEEE C 62.41-2002 Test Reports. Include complete let-through voltage test data (not SVR or VPR), test graphs and scope traces for each and every mode for each product submitted for Category's C, B, A (including Cat A, 2kV, 67A, 100kHz ring wave at both 90 & 270 degree electrical phase angles) This testing shall be conducted exactly as described below.

1. Let-through Voltage Test Parameters: Positive Polarity, Net voltages are peak (±10%). All tests are static except 150 V MCOV modes. Let-through voltages on static tests calculated by subtracting sinewave peak from let-through measured from zero. 150 V MCOV mode let-through voltages measured from the insertion point on the sinewave. Each phase is the average of the 3 modes. In order to duplicate the results, the specified mode must be tested for all three phases (except N-G) and averaged together. (Individual mode or shot results may vary by more

than 10%. Scope Settings: Time Base = 10 microseconds, Sampling Rate = 500 Megasamples/sec. These settings assure Let-through voltages test results are accurate). All tests performed with 6" lead length (external to the enclosure), simulating actual installed performance.

E. Substitutions will not be approved. Products submitted must be one of the manufacturers listed and part numbers as listed.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For surge protective devices to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Applicable Documents:

1. ANSI/IEEE Std C62.41.1™-2002, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits
2. ANSI/IEEE Std C62.41.2™-2002, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
3. ANSI/IEEE Std C62.45™ -2002, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits
4. ANSI C84.1, American National Standard for Electric Power Systems and Equipment – Voltage Ratings (60 Hertz)
5. IEEE Standard 1100-2005, IEEE Recommended Practice for Power and Grounding Electronic Equipment - Section 8.6.1
6. UL 1283, Electromagnetic Interference Filters
7. UL 1449, Surge protective Devices
8. California Electrical Code (CEC)

B. Qualification Data: Agency Approval/Testing Agency Qualifications - An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a Nationally Recognized Testing Laboratory (NRTL) as defined by OSHA n 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. All SPD devices shall be tested and listed to UL 1449 Current Edition& UL 1283 by a NRTL (CSA, UL, etc)
2. All SPD devices shall comply with IEEE C62.41.2 and test devices according to IEEE C62.45.

C. All SPD devices at the service entrance, distribution panels, branch panels, motor control centers, meter centers, disconnects and individual load applications must be provided by same SPD manufacturer.

D. Manufacturer Qualifications: At least 10 years engineering experience in the design and manufacture of permanently connected SPD devices.

1. Operates a Quality System Certified manufacturing facility as ISO 9001:2000 compliant.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined inthe CEC, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.8 COORDINATION

A. Coordinate location of field-mounted surge suppressors to allow adequate clearances for maintenance.

1.9 WARRANTY

A. The manufacturer shall provide unlimited free replacement of the entire SPD (not just modules, components or sub-assemblies) for all inoperable SPD during the warranty period. Minimum warranty period shall be 25 (Twenty-Five) years. Acceptable manufactures listed that do not meet the 25-year warranty as standard shall submit a letter extending the warranty with the product submittal.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The listing of a manufacturer as “acceptable” does not imply automatic approval. It is the sole responsibility of the Contractor to ensure that any submittals made are for products that meet or exceed the specifications included herein. Subject to compliance with requirements, provide products by the following manufacturer(s) and listed part numbers, all others will be rejected.

SPD Manufacturer	Service Entrance Type 1, 20kA I_n (Only) (240kA/phase)	Distribution Panelboards 400A & Larger Type 2, 20kA I_n (Only) (180kA/phase)	Branch Panelboards (under 400A) w/ Sine-Wave Tracking Type 2, 20kA I_n (Only) (120kA/phase)
Surge Suppression Incorporated Contact Rob Baczewski 850.240.2030	LSED3Y1AC-17 (120/208 Volt Wye) LSED3Y2AC-17 (277/480 Volt, Wye) LSED3N4AC-17 (480 Volt, Delta)	SDLB3Y1AC-17 (120/208 Volt, Wye) SDLB3Y2AC-17 (277/480 Volt, Wye) SDLB3N4AC-17 (480 Volt, Delta)	CKLB3Y1AC -N-17 (120/208 Volt, Wye) CKLB3Y2AC -N-17 (277/480 Volt, Wye) CKLB3N4AC -N-17 (480 Volt, Delta)

rbaczewski@surgesuppression.com	Phy. Size - 8” x 5” x 4” (5lbs.)	Phy. Size - 8” x 5” x 4” (5lbs.)	Phy. Size - 8” x 5” x 4” (5lbs.)
Asco Power Tech / Square D by Schneider Electric 800.237-4567 Ste-ven.Christy@se.com	465120YP30ARCE10 (120/208 Volt Wye) 465277YP30ARCE10 (277/480 Volt, Wye) 460480DP30ACCE10 (480 Volt, Delta) Phy. Size - 12” x 12”x 7” **SWBD Applications (integral)** 451120YP30ACCN10 (120/208 Volt Wye) 451277YP30ACCN10 - (277/480 Volt, Wye) 451480DP30ACCN10 - (480 Volt, Delta)	445120YP30ACCJ20 (120/208 Volt, Wye) 445277YP30ACCJ20 (277/480 Volt, Wye) 440480DP30ACCJ20 (480 Volt, Delta) Phy. Size - 10” x 5” x 4”	445120YP15ACCJ20 (120/208 Volt, Wye) 445277YP15ACCJ20 (277/480 Volt, Wye) 440480DP20ACCJ20 (480 Volt, Delta) Phy. Size - 10” x 5” x 4”
Siemens (Mersen TPMOV based SPD ONLY. Use of TPS4 is prohibited.)	TPS3CL12300X01 (120/208 Volt Wye) TPS3EL12300X01 (277/480 Volt, Wye) TPS3F12250X01 (480 Volt, Delta) Phy. Size - 12” x 12” x 7” (20lbs.) **SWBD Applications (integral)** TPS3CL1230PXD1 (120/208 Volt Wye) TPS3EL1230PXD1 (277/480 Volt, Wye) TPS3F1230PXD1 (480 Volt, Delta)	TPS3C1120D2 (120/208 Volt Wye) TPS3E1120D2 (277/480 Volt, Wye) TPS3F1120D2 (480 Volt, Delta) Phy. Size - 6” x 6” x 4” (5lbs.)	TPS3C1115D2 (120/208 Volt Wye) TPS3E1115D2 (277/480 Volt, Wye) TPS3F1115D2 (480 Volt, Delta) Phy. Size - 6” x 6” x 4” (5lbs.)

2.2 GENERAL REQUIREMENTS

A. Surge Protection Devices Minimum Requirements:

1. ANSI/UL 1449 Current Edition .

a. Power and Protection Status LED indicators
b. Audible Alarm
c. Form C dry contacts rated at 5A and 250V ac one normally open and one normally closed.
d. Surge Counter (Service Entrance Only)

2. When breakers or disconnects accessories are unavailable to legally land conductors at disconnects serving fire pumps, direct wired elevator disconnects, escalators, or direct wired to service ahead of breakers, a separate dedicated safety switch or enclosed circuit breaker shall be connected to the service to serve as the SPD's disconnecting means.
3. Permanently-connected, parallel mounted.
4. Solid-state clamping components to limit the surge voltage and divert the surge current. SPD components that "crowbar" (e.g. spark gaps, gas tubes, SCR's, "pill stacked or stacked MOVs," etc.) not allowed.
5. Capable of sustaining 115% of nominal RMS voltage continuously without degrading.
6. The SPD device shall be tested and listed by a NRTL as a complete assembly to a symmetrical fault current rating greater than or equal to the rating of the connected panel, in accordance with **[NEC][CEC]** Article 285 and shall be marked with the short circuit current rating.

B. Modes of Protection:

1. SPD units shall provide descrete 10 mode Line to Line, Line to Neutral, Line to Ground, and Neutral to Ground protection. Reduced mode devices are not acceptable.

C. Fault Current Protection for Non-Mersen or Prosurge TPMOV based SPDs

1. Provide as a minimum, over-current, over temperature protection in the form of component-level thermal fusing to ensure safe failure and prevent thermal runaway. This component-level fusing shall be an integral part of the MOV itself, and not silver wire (or other) independently layed across each MOV.
2. Provide integral short circuit current fusing within each device. This fusing will be independent of the "component-level" fusing and specifically for over-current protection and shall be constructed utilizing surge rated, cartridge fuses and not rated 'silver-fuse-wire' (or other).
3. The fusing mechanisms employed must effectively coordinate their performance in conjunction with the high current abnormal over-voltage testing under UL 1449 Current Edition.

4. The use of any mechanical or electro-mechanical thermal/over-current protection (i.e. moving parts and/or springs and shutters), in combination with or for the protection of the suppression elements are expressly prohibited and will be rejected.

D. Fault Current Protection for TPMOV based SPDs

1. SPDs are to be constructed with Mersen or Prosurge Thermally Protected Metal Oxide Varistors (TPMOVs). Every suppression component of every mode, including N-G, shall be protected by internal and thermal overtemperature controls. SPDs relying upon external or supplementary installed safety disconnectors do not meet the intent of this specification.

E. For all Hospital and Healthcare Facility Projects, SPD manufacturer is to remove the "sine-wave tracking" circuitry in the N-G mode. The SPD device itself however, must still incorporate the standard threshold N-G mode circuitry within the device.

F. Maintenance Restrictions

1. No suppression unit shall be supplied which requires scheduled preventive-maintenance or replacement parts. Units requiring functional testing, special test equipment, or special training to monitor surge protection device (SPD) status are not acceptable. SPD devices shall require no routine maintenance. SPD devices are considered non-repairable items and shall be fully replaced upon failure.

G. Enclosures

1. Unless otherwise noted, NEMA 1 (or better) enclosures for indoor installations and NEMA 4X or better enclosures for outdoor/wet locations shall be utilized.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide surge suppression at each building service entrance switchboard or panelboard, and at other locations as indicated on the Contract Drawings.

B. Provide surge suppression at each fire pump (both normal and emergency sides) with disconnecting means for SPD.

C. Install devices at service entrance on load side, with ground lead bonded to service entrance ground.

D. Install devices for panelboard and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

1. Provide multipole, 30 amp circuit breaker as a dedicated disconnect for suppressor, unless otherwise indicated.

3.2 REQUIRED SURGE PROTECTIVE DEVICES (SPDs) – EMERGENCY LOADS

A. Panelboards and Switchboards that are part of the NEC 700 Emergency branch, or the NEC 517 Essential Electrical System shall have an SPD provided for each panelboard and/or switchboard.

B. Provide 30 amp, 3 pole circuit breaker to serve each SPD.

1. Provide SPD regardless if shown on electrical one-line, riser, and/or plans or not.

3.3 FIELD QUALITY CONTROL

A. Electrical Service, Distribution Panels, Branch Panelboards, and Motor Control Centers:

1. Provide surge protective device at each building normal and emergency power service entrance and at other panelboard and motor control center locations as indicated on the drawings. The SPD shall be located immediately adjacent to the switchboard or panelboard being protected (close-nipple to panelboards). The SPD may not be located integral within the switchboard or panelboard(s) unless specifically noted on drawings. SPD devices not meeting or exceeding the performance of this specification will be deemed unacceptable.
2. Install the SPD with #10 AWG minimum conductors to a 30-amp breaker in panel per manufacturer's installation instructions. The phase and neutral conductors serving the SPD shall be twisted together (one twist per 12" of lead length) to reduce the SPD system input impedance and kept at the minimum length. The SPD shall be installed in strict accordance with the manufacturer's recommended practices and in compliance withCEC requirements. If the SPD manufacturer requires larger size conductors and breaker, Contractor shall provide conductors and breaker size per manufacturer's requirements. No. 10 conductors and 30 amp breaker size are based on Surge Suppression Inc. requirements. If Contractor chooses to use an alternate manufacturer, Contractor shall provide conductors and breaker size per manufacturer's requirements at no additional cost.
3. If lead lengths exceed 18" the Contractor responsible for installation must contact the surge suppression manufacturer for installation assistance.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
2. After installing SPD devices but before electrical circuitry has been energized, test for compliance with requirements.
3. Complete startup checks according to manufacturer's written instructions.

C. SPD device will be considered defective if it does not pass tests and inspections.

D. The surge protection installation shall be certified by a licensed electrician that the installation is in accordance with the manufacturer's recommendations, CEC requirements and the requirements of the specification above. Any deficiencies noted shall be corrected by the Contractor. Provide written documentation of this inspection as part of the closeout documents/manual.

3.4 STARTUP

A. Do not energize or connect service entrance equipment, panelboards and other electrical equipment to their sources until SPD devices are installed and connected.

B. Do not perform insulation resistance tests of the distribution wiring equipment with the SPD installed. Disconnect before conducting insulation resistance tests, and reconnect immediately after the testing is over.

END OF SECTION

SECTION 26 51 00 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Interior luminaires, lamps, and drivers.

2. Emergency lighting units.

3. Exit signs.

4. Area of Refuge signs.

B. Related Sections include the following:

1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

2. Division 26 Section "Wiring Devices" for manual wall-box dimmers.

3. Division 26 Section "Seismic Restraint For Electrical Systems" for requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. TM-30: IES standard for measuring LED color rendition

D. IP: International Protection or Ingress Protection Rating.

E. CU: Coefficient of utilization.

F. LED: Light Emitting Diode.

G. LER: Luminaire efficacy rating.

H. Lumen: Measured output of lamp and luminaire, or both.

I. Luminaire: A complete lighting unit consisting of a light source(s) and ballast(s) or driver(s) (when applicable), together with the parts designed to distribute the light, to position and protect the light source(s), and to connect the light source(s) to the power supply.

1.4 ACTION SUBMITTALS

A. Submit catalog literature for each luminaire specified in PDF form with index, assembled in luminaire "type" alphabetical order, with specified luminaire data as required below.

B. Contractor shall provide submittals for luminaires as indicated in the "Luminaire Schedule." Where an alternate manufacturer is indicated for a specific luminaire with no catalog number indicated for the alternate manufacturer, provide alternate luminaire that is equal in all characteristics as the cataloged luminaire. Luminaires without alternate manufacturers noted shall be provided with no substitutions and/or alternates.

C. Excess delivery times shall not be an acceptable cause for substitution of specified luminaires. Notify Architect/Engineer of any long lead luminaires that may impact project schedule within two weeks of contract award. Beyond two weeks the contractor is responsible for any costs associated with expediting the manufacturing process of the specified luminaire and/or cost associated with an approved substitute luminaire is allowed by Architect/Engineer.

D. Product Data: For each luminaire, include data on features, accessories, finishes, and the following:

1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.

2. Emergency lighting units including battery and charger.

3. Details of attaching luminaires and accessories.

4. Details of installation and construction.

5. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project, IES LM-79/80, and DOE CALiPER.

a. Photometric data shall be certified by a qualified independent testing agency or by manufacturer's laboratory with a current accreditation under the

National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

6. Life, output (lumens, CCT, CRI, and TM-30), and energy-efficiency data for LED source.

7. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.

E. Shop Drawings: For nonstandard or custom luminaires. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Wiring Diagrams: For power, signal, and control wiring.

F. Samples: For each luminaire requested to be provided during submittal review. Each Sample shall include the following:

1. LEDs and drivers, installed.

2. Cords and plugs.

G. Installation instructions.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For luminaires**,** accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Qualification Data: For qualified agencies providing photometric data for luminaires.

C. Field quality-control reports.

D. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lighting equipment and luminaires to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp/source types used on Project; use ANSI and manufacturers' codes.

1.7 QUALITY ASSURANCE

A. Equivalency of luminaires is determined by Engineer and includes the following data for comparative purposes.

1. Efficiency.

2. Efficacy.

3. Distribution.

4. Light color quality

5. Construction.

6. Design compatibility.

7. Manufacturer reliability based upon past performances.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

C. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.

D. LED Color Consistency: IES TM-30 color data shall be provided for all luminaires.

E. Electrical Components, Devices, and Accessories: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

F. Comply with all applicable codes.

G. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class, division, and group of hazard by FM Global.

1.8 COORDINATION

A. Coordinate layout and installation of luminaires and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.9 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: Five years from date of Substantial Completion. Full replacement warranty shall apply for the full five years.

B. Special Warranty for LED luminaires: Manufacturer's standard form in which manufacturer agrees to repair or replace luminaires that fail in materials or workmanship within specified warranty period.

1. Warranty Period for LED luminaires: Five years from date of Substantial Completion.

1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.

2. Luminaires (including accessories): 5 for every 100 of each type. Furnish at least one of each type.

3. Battery and Charger Data: 1 for each emergency lighting unit.

4. Drivers: 5 for every 100 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product indicated on Drawings where only one manufacturer is listed, provide one of the products indicated on Drawings where multiple manufacturers are listed.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES AND COMPONENTS

A. Provide luminaires of the size, type and rating indicated in “Luminaire Schedule”, complete with, but not necessarily limited to, lamps/modules, lampholders, reflectors, drivers, starters, wiring and any other accessories required for a complete working installation.

B. Luminaire catalog numbers do not necessarily include all accessories and are intended to serve as a guide in defining types and manufacturers of luminaire only.

C. The contractor shall ensure that the luminaire is UL/ETL listed for the ambient conditions where installed. Extra compensation will not be permitted for failure to coordinate luminaires with their ambient conditions.

1. Luminaires located exterior to the building and/or in unconditioned damp spaces and under cover from direct weather exposure shall be UL/ETL listed as “Suitable for Damp Locations” unless noted otherwise.

2. Luminaires located exterior to the building and/or in unconditioned wet spaces and in direct contact with the weather or in washdown areas shall be UL/ETL listed as “Suitable for Wet Locations” unless noted otherwise.

D. Luminaires installed with direct contact with insulation shall have an “IC” rating for direct contact with insulation. Verify if luminaires will be in contact with insulation prior to installation. Notify Architect/Engineer of any conflicts.

E. Gasketing material shall be vinyl or other non-aging type material as approved by Engineer.

F. Provide proper trim for each luminaire as required for various types of ceiling being installed throughout the project; plaster rings, luminaire ends or caps, suspension units, mounting brackets and/or other accessory parts necessary for a complete luminaire.

G. Recessed Luminaires: Comply with NEMA LE 4 for ceiling compatibility for recessed luminaires.

H. Metal Parts: Free of burrs and sharp corners and edges.

I. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

J. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

K. Diffusers, Covers, and Globes:

1. Acrylic Luminaire Diffusers: Plastic for clear lenses and diffusers shall be formed of colorless 100% virgin acrylic, as manufactured by Atohaas, DuPont or equally acceptable manufacturer. The quality of the raw material must meet or exceed IES, SPI, and NEMA Specifications and shall not exceed a yellowness factor of 3 after 2,000 hours of exposure in the Fade-meter or as tested by an independent testing laboratory. Acrylic plastic lenses and diffusers shall be properly cast, molded or extruded as specified, and shall remain free of any dimensional instability, discoloration, embrittlement, or loss of light transmittance for at least 10 years.

   a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.

   b. UV stabilized.

2. Glass: Glass used for lenses, refractors, and diffusers in luminaires shall be tempered for high impact and heat resistance; where clear glass has been specified, the glass shall be crystal clear in quality with a transmittance of not less than 88%. Where luminaire glass lenses are specified glass lenses shall be provided and plastic lenses shall not be substituted.

L. Factory-Applied Labels: Comply with UL 1598 (or ETL tested to UL 1598 standard).

1. All luminaires shall have a factory-applied label near lamp/source socket stating maximum wattage of lamp/source allowed in luminaire. Maximum wattage to be stated is wattage as shown on luminare schedule. Circuits are based on these wattages. Any failure to comply with this requirement shall be responsibility of contractor. Location of labels must meet acceptance of lighting designer, architect and engineer.

2. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

   a. "USE ONLY" and include specific lamp type.

   b. Lamp diameter, shape, size, wattage, and coating.

   c. CCT and CRI.

2.3 CUSTOM LUMINAIRES

A. Custom luminaire manufacturers must supply working sample and complete shop drawings for design team for review. Sample luminaires will become property of the Client or their design team.

B. Luminaires shall be UL or ETL approved for their proposed location.

C. Exposed hardware shall be concealed where appropriate unless as a design feature.

D. Custom luminaire manufacturers shall have a minimum 5 years of experience in the design and manufacturing of luminaires of the type, quantity and quality shown. Prequalification submissions must include a list of completed projects, dated catalog pages or drawings indicating length of experience.

E. Materials, accessories and other related luminaire parts shall be new and free of any defects which in any manner may impair their character, appearance, strength or ability and function effectively protected from damage or injury from the time of fabrication until final acceptance of work.

F. Sheet metal shall be free from tool marks, and dents and shall have accurate angles as sharp as compatible with the gauge of the required metal. Intersections and joints shall be formed true of adequate strength and structural rigidity to prevent distortion after assembly.

G. Housing shall be so constructed that electrical components are easily accessible and replaceable without removing luminaires from their mountings or disassembly of adjacent construction.

H. Luminaires shall be completely wired at the factory. Luminaires shall come with electrical wire whips in accordance with local codes and in accordance with actual installation requirements.

I. Leaks within luminaires and between luminaires and mounting surface will not be tolerated.

J. Steel and aluminum luminaires, screws, bolts, nuts and other fastening and latching hardware shall be cadmium or equivalent plated. For stainless steel luminaires, hardware shall be stainless steel or bronze. Luminaires must be assembled and gasketed properly to prevent galvanic action.

2.4 LED LUMINAIRES

A. LED luminaires shall provide a continuous and controllable light source. Lamp output and dimensions shall be in accordance with contract drawings and specifications. LED luminaire lumen output will be in accordance with the specifications and shall not depreciate more than 20% after 10,000 hours of use. Rated lumen output for LED

luminaires to operate in ambient temperature of minus 4°F (20°C) -20°C to 122°F (50°C) +50°C. Luminaires to have minimum life of 50,000 hours.

B. All LEDs used in the LED luminaires must meet the following conditions:

1. Will be of high brightness and proven quality.

2. Shall be driven digitally with pulse width modulation control to prolong life and maintain consistency of lumen output.

3. Shall have a CRI no less then 80 (unless specific TM-30 rating is otherwise specified.)

C. All connections to luminaires will be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.

D. Fuse Protections: All power supply outputs will be either fuse protected or PTC-protected as per Class 2 UL listing. All luminaires will have built-in fuse protection. All power supplies will provide for knockouts for conduit connections or clamp-style connection for the low-voltage wiring.

2.5 LED DRIVERS (POWER SUPPLIES)

A. All LED drivers to be compatible with LEDs. All LED luminaires and drivers (power supplies) shall be furnished by single manufacture to insure compatibility.

B. Electric Characteristics (at 77°F (25°C) ambient temperature)

1. Input Voltage Range - 108V to 277V

2. Efficiency Minimum – 80%

3. Output Current Regulation Range (+/-) 5%A

4. Total Harmonic Distortion (THD) – 20% maximum

5. Power Factor – 0.9 minimum

6. Crest Factor (LED Current) – 1.5 maximum

7. FCC Class B for Conducted EMI

8. FCC Class A for Radiated EMI

9. Drivers life – 50,000 hours minimum

2.6 EXIT SIGNS

A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.

2. AC/Battery Powered Exit Signs : Integral automatic charger in a self-contained power pack.

a. Battery: Sealed, maintenance-free, nickel-cadmium type.

b. Charger: Fully automatic, solid-state type with sealed transfer relay.

c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

2.7 AREA OF REFUGE SIGNS

A. Description: Sign to be a listed UL 924 exit type sign with “AREA OF REFUGE” lettering and ADA wheelchair accessible symbol. Comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.

2. AC/Battery Powered Area of Refuge Signs : Integral automatic charger in a self-contained power pack.

a. Battery: Sealed, maintenance-free, nickel-cadmium type.

b. Charger: Fully automatic, solid-state type with sealed transfer relay.

c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

2.8 EMERGENCY LIGHTING UNITS

A. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.

1. Battery: Sealed, maintenance-free, lead-acid type.

2. Charger: Fully automatic, solid-state type with sealed transfer relay.

3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or luminaires where noted on plans.

7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.

2.9 LAMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following (unless otherwise specified):

1. SORAA (LED lamps ONLY)

2. TCP (LED lamps ONLY)

3. Archipelago (LED lamps ONLY)

4. Green Creative (LED lamps ONLY)

5. Feit Electric (LED lamps ONLY)

B. LED Lamps

1. All LED lamps of the same type shall be of the same manufacturer (Ex. decorative, low voltage).

2. Average rated life of 25,000 hours minimum.

3. Lamps shall have a minimum warranty of three years.

4. Lamps shall have a minimum CRI of 80, unless amber LED.

5. Lamps shall be rated for use in fully enclosed luminaires where installation requires this rating.

6. Lamps shall be rated for use in wet location where installation requires this rating.

7. Lamps shall include shatterproof rating in applications where lamps are located over food preparation areas.

2.10 LUMINAIRE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Suspended luminaires shall have swivel type aligner hangers in ceiling boxes to ensure plumb suspension.

C. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire. Where stems are furnished by luminaire manufacturer, verify length prior to releasing shipment.

D. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single luminaire. Finish same as luminaire. Where stems are furnished by luminaire manufacturer, verify length prior to releasing shipment.

E. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage, minimum.

F. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage, minimum.

G. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

H. Hook Hangers: Integrated assembly matched to luminaire and line voltage and equipped with threaded attachment, cord, and locking-type plug.

I. Do not use ceiling grid as support for luminaires. Connect support wires or rods to building structure.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Architect's and/or Interior Designer's reflected ceiling plans indicate actual location of all luminaires. Notify Architect/Engineer of any conflicts between these plans and electrical documents prior to rough-in and installation.

B. Architect's and/or Interior Designer's elevation and/or section plans may show actual location of luminaires that are not documented on the reflected ceiling plans. If luminaires are not shown on elevation and/or section plans, install at height noted on the electrical documents. Notify Architect/Engineer of and conflicts between these plans and electrical documents prior to rough-in and installation.

C. Temporary Lighting: If it is necessary, and approved by the Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps and reinstall.

D. Verify adequacy of headroom and non-interference with other equipment such as ducts, pipes and openings. Report to Architect/Engineer any conflict between these plans and electrical documents.

E. Install luminaires in mechanical and unfinished areas after ductwork and piping installation. Adjust luminaire locations to provide the best lighting for equipment access and service locations. Locate luminaires 8'-6" (2600 mm) above floor or at suitable locations within space or on walls but not lower than 7'-0" (2200mm).

F. Adjustable luminaires shall be aimed as directed by Architect/Interior Designer/Engineer.

G. Special care shall be taken to assure light-tight joints between recessed luminaires and ceiling systems.

H. Recessed luminaires which are installed in rough textured ceiling surfaces whereby light may be emitted between luminaire frame and ceiling surface shall have black self-adhesive polyfoam gasketing installed around inside edges of frame to prevent light leaks.

I. Install luminaires in a workmanlike manner. Care shall be taken in placement of luminaire outlets and surface-mounted luminaires to maintain alignment, spacing, layout, and general arrangement shown on drawings. Contractor may vary these dimensions slightly in order to clear obstructions. Any major changes in the arrangement must be approved by Engineer.

J. Luminaires: Set level, plumb, and square with ceilings and walls. Install lamps in each luminaire.

K. Air-Handling Luminaires: Install with dampers closed and ready for adjustment.

L. Coordinate with trades so luminaires are properly aligned with items such as diffusers, grilles, and speakers

M. If necessary, relocate luminaires as directed by engineer so there will be no conflict with other equipment.

N. Make luminaire holes for wire entrance with knock-out punches or hole saw, remove burrs. Do not cut holes with tinsnips.

O. In areas where there is exposed food, clean equipment, utensils, linens or unwrapped single-service and single use articles, lamps shall be shielded, coated or otherwise shatter-resistant.

P. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

Q. Clean luminaires of dirt and debris prior to acceptance.

R. Maintain clearance as required in **[Section 41 0. 116 of the NEC][the CEC]** and other NFPA sections. Notify Engineer of any conflict, prior to rough-in.

S. Comply with all relevant Federal, State, Local and Agency guidelines when disposing of lighting waste.

T. Electrical contractor shall remotely locate all drivers/transformers called for in the contract documents in a well ventilated and easily accessible space to comply with all codes.

3.2 LED DRIVER INSTALLATION

A. Coordinate location of non-integral drivers with architect.

B. Install drivers per manufacturers requirements in accessible area.

1. Coordinate the length of the low voltage wiring from the driver to the luminaire with the manufacturer requirements.

C. Drivers shall be sized to provide 20% spare capacity.

3.3 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

C. At time of Substantial Completion, replace lamps in luminaires which are observed to be noticeably dimmed after Contractor's use and testing, as judged by Engineer.

3.5 ADJUSTING

A. Provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. Adjust aimable luminaires in the presence of Architect.

B. Adjust adjustable luminaires to satisfaction of Architect/Engineer.

END OF SECTION

DIVISION 27

COMMUNICATIONS

SECTION 27 05 00 - COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Low voltage electrical equipment coordination and installation.
2. Access Panels
3. Common low voltage electrical installation requirements.

1.3 DEFINITIONS

A. Code. National, State and Local Electrical codes including OSHA requirements.

B. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

C. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

D. Electrical ductbank: Assembly consisting of multiple electrical conduits embedded in earth or concrete.

E. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

F. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

G. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

H. Home Run: The portion of a branch circuit between the serving panelboard and the first electrical outlet, lighting fixture, or other electrical load connected to the circuit.

I. Provide. Used within these sections “provide” shall mean “furnish and install.” “Furnish” shall mean “to purchase and deliver to the project site complete with every necessary appurtenance and support,” and “install” shall mean “to unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project.”

J. Low voltage: 50 to 600 volts.

K. Medium voltage: 601 to 35,000 volts.

L. High voltage: 35,001 volts and greater.

M. Signal voltage: NEC class 1, 2, or 3 remote control, signaling, or power limited circuits.

1.4 SCOPE

A. Drawings and Specifications form complementary requirements; provide work specified and not shown, and work shown and not specified as though explicitly required by both. Although work may not be specifically shown or specified, provide supplementary or miscellaneous items, appurtenances, devices, and materials obviously necessary for a sound, secure and complete installation.

B. It is the intent that these Specifications and associated Drawings establish minimum requirements for products and equipment with the intent to provide electrical service, distribution and systems finished, tested and ready for operation. Incidental detail that is not shown or specified, but necessary for proper installation and operation shall be included in the work and in these Contractor's estimates, the same as if specified. Locations of all equipment and material shall be adjusted at no extra cost to the Owner, to accommodate the work interferences anticipated and/or encountered. Prior to installation, determine the exact route and location of each raceway and piece of equipment to minimize conflicts with other trades.

C. This project will be phased, as defined by the Owner. This may necessitate the provision of temporary electrical utilities. All associated appurtenances with the utilities shall be provided as part of this project in the appropriate phase coordinated with Owner’s phasing requirements.

D. Information and components shown on riser diagrams but not shown on plans, and vice versa, shall be provided as if expressly required on both.

E. Except where modified by a specific notation to the contrary, it shall be understood that the indication and/or description of any item, in the drawings or specifications or both, carries with it the instruction to furnish and install the item, regardless of whether or not this instruction is explicitly stated as part of the indication or description.

F. Items referred to in singular number in Contract Documents shall be provided in quantities necessary to complete work.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than 0 deg F (minus 18 deg C) or exceeding 104 deg F (40 deg C).
2. Humidity: Less than 95 percent (noncondensing).
3. Altitude: Not exceeding 6600 feet (2000 m), or 3300 feet (1000 m) if equipment includes solid-state devices.

1.6 MODIFICATIONS IN LAYOUT

A. Drawings are intended to outline the scope of work required and are not intended to be installation drawings. Drawings are not intended to be absolutely precise; they are not intended to specify or to show every offset, fitting, and component nor do they show the exact routing and locations needed to coordinate with structure and other trades and to meet Architectural requirements. The purpose of the drawings is to indicate a systems concept, the main components of the systems, and the approximate geometrical relationships. Based on the systems concept, the main components, and the approximate geometrical relationships, the contractor shall provide all other components and materials necessary to make the systems fully complete and operational.

B. Unless specifically stated to the contrary, no measurement of a technology drawing derived by scaling shall be used as a dimension to work by. Dimensions noted on the technology drawings are subject to measurements of adjacent and previously completed work. Measurements shall be performed prior to the actual installation of equipment.

C. Prior to installation of visible material and equipment (including access panels) in finished spaces, review Architectural Drawings for desired locations and where not definitely indicated, request information from Architect.

D. Check Contract Documents, as well as, Submittals and Shop Drawings of all subcontractors to verify and coordinate spaces in which work of Divisions 21 through 28 will be installed.

E. Make reasonable modifications in layout and components needed to prevent conflict with work of other trades. Systems shall be run parallel with or perpendicular to major architectural and structural building elements.

F. Where conflicts or potential conflicts exist and engineering guidance is desired, submit sketch of proposed resolution to Architect for review and approval.

1.7 COORDINATION

A. Coordinate arrangement, mounting, and support of communications equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of installation and removal of the equipment with minimum interference to other installations or equipment.

B. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

1.8 COORDINATION DRAWINGS

A. When included as part of the Contract Documents, there shall be full cooperation and coordination of all specialty trades.

B. This Division's contractors shall comply fully with the requirements set forth in the Division 23 Section "BIM Coordination Drawings" specification section.

1.9 RECORD DOCUMENTS

A. Record Drawings are specified in Division 01 Section "Project Record Documents."

B. The Low Voltage Contractor shall keep a detailed up-to-date record, of the manner and location in which installations are actually made, indexing each drop, backbone, pull box and equipment / racks. Record documents are to reflect all changes in work including change orders, field directives, addenda from bid set of Contract Documents, request for information responses, etc. Upon completion of the project, the contractor shall modify the project electronic drawing and specification files to incorporate this information. Modified documents shall be turned over to the Owner and Engineer in both electronic and hard paper copy formats. Record drawings shall also include:

1. Locations of buried conduit or similar items. Include buried depth.
2. Field changes of dimension or detail.
3. Changes made by field order or change order.
4. Details not on original contract drawings.

C. As Built Drawings – Refer to the individual Division 27 Specification Section for As-Built Drawing requirements.

D. In the event of a conflict between the drawings and specifications, this Contractor shall base their bid on the greater quantity, cost or quality of the item in question, unless conflict is resolved by an addendum.

E. Take photographs of all concealed equipment in gypsum board ceilings, shafts, underground (buried) piping routes and supports and other concealed, inaccessible work. At completion of work, make copies of photographs with written explanation for each photo. These shall become part of Record Documents.

F. Underground and utility work shall be located by distances to landmarks, such as building foundations. Give actual dimensions of everything installed including elevations and elevations at each change in direction.

G. Drawings shall also show record condition of details, sections, riser diagrams, control changes and corrections to schedules. Schedules shall incorporate actual manufacturer and make and model numbers of final equipment installation.

H. THE ENGINEER/ARCHITECT WILL NOT CERTIFY THE ACCURACY OF THE RECORD DRAWINGS - THIS IS THE SOLE RESPONSIBILITY OF THE CONTRACTOR.

I. When required by the jurisdiction, each trade shall submit the record set for approval by the building department in a form acceptable to the department. Any document format size changes, and supplemental information required for the submittal are the responsibility of the contractor.

J. Quality of Record Documents shall equal or exceed that of original Contract Documents.

K. The record documents shall be submitted in electronic media format to the Architect/Engineer for review and approval, prior to Application for Final Payment.

1.10 MAINTENANCE MANUALS AND OPERATING INSTRUCTIONS

A. Obtain at time of purchase of equipment, three copies of operation, lubrication, and maintenance manuals for all items. Assemble literature in a coordinated manual using loose leaf sheets in a three-ring binder(s). Manual shall contain names and addresses of manufacturers and local representatives who stock or furnish repair parts for items or equipment.

B. The manuals shall include the following and shall have an index of contents and tabs for each Specification Section and each piece of equipment specified in that Section and be provided in the order listed below, per Specification Section.

1. Copies of all approved submittals/shop drawings.
2. Manufacturer's operating and maintenance instructions and parts lists of all items or equipment. Where manufacturer's data includes several types or models, the applicable type or model shall be clearly designated.
3. Startup and shutdown procedures.
4. Test records.
5. Wiring diagrams.
6. Lubrication instructions detailing type of lubricant, amount, and intervals recommended by manufacturer for each item of equipment.

7. Owner's written acknowledgement of satisfactory completion of instruction period.

C. Furnish three copies of manuals to Architect for approval and distribution to Owner. Deliver manuals no less than 30 days prior to acceptance of equipment to permit Owner's personnel to become familiar with equipment and operation prior to acceptance.

D. Operating instructions: Upon completion of installation or when Owner accepts portions of building and equipment for operational use, instruct Owner's operating personnel in any or all parts of all systems. Factory-trained personnel shall perform instructions.

1.11 SUBMITTAL PROCEDURE AND FORMAT

A. This Article supplements Division 1.

B. Submittal Cover Sheet

1. Submittal data for each product shall include a copy of the following cover sheet completely filled out. Incomplete or incorrect cover sheet submittal shall constitute reason for rejection.
2. Material submittals shall be organized by specification section. All items requiring a submittal per each specification section shall be combined into a single submittal. Provide each section/item within that submittal with its own cover sheet labeled and tagged to match the drawings.

SHOP DRAWING COVER SHEET				
PROJECT:		CONTRACTOR:		
DIVISION NO.:		SECTION NO.:		
DESCRIPTION:				
CONTRACT DRAWING REFERENCE NO:				
EQUIPMENT TAG:				
SUBMISSION (CIRCLE ONE): FIRST, SECOND, THIRD, FOURTH				
DATE:				
INFORMATION AND CHECKLIST				
1.	Contractor's Log #ID			
2.	Name, address, and phone number of supplier.			
3.	Are all specified or scheduled items included and exactly match scheduled/specified items?	Yes	No	
4.	Is this item a substitution?	Yes	No	
5.	Are deviations clearly identified?	Yes	No	
6.	Does equipment fit space shown on construction documents, coordination drawings, and actual field conditions?	Yes	No	
7.	Has support, erection, weights, and installation been coordinated with all trades?	Yes	No	
8.	Does the proposed installation void warranties and/or violate UL or code requirements?	Yes	No	
9.	Does this material/equipment add expense to any other trade or project costs?	Yes	No	
10.	Does equipment require interface with other trades? List divisions and specifics requiring coordination?	Yes	No	
11.	Is control interface coordinated?	Yes	No	
12.	List electrical characteristics (V/Ph/A)			

3. Multiple Re-submittals: The Engineer will review the first submittal from the contractor and respond with comments and will review one re-submittal for the same item(s) from the contractor and respond with comments. If the contractor is required to make subsequent submittals for the same item(s) the Engineer shall be compensated by the contractor for the time to review each subsequent re-submittal. The contractor shall agree to compensate the Engineer a minimum of $500 per each re-submittal item.
4. Shop Drawings showing layouts of systems shall contain sufficient plans, elevations, sections, details and schematics to describe work clearly. They shall be 1/4 inches = 1 foot 0 inch scale unless specified otherwise.
5. Shop drawings and submittals showing manufacturer's product data shall contain detailed dimensional drawings, accurate and complete description of materials of construction, manufacturer's published performance characteristics and capacity ratings (performance data, alone, is not acceptable), electrical requirements and wiring diagrams. Drawings shall clearly indicate location (terminal block or wire number), voltage and function for all field terminations, and other information necessary to demonstrate compliance with all requirements of Contract Documents.
6. Provide shop drawing submittals showing details of electrical connections to ALL equipment. If connection details are not submitted and connections are found to be installed incorrectly in the field, this contractor shall reinstall them within the original contract price.
7. Shop drawings for different systems and equipment shall be bound separately by specification section as indicated above and not bound by manufacturer. Each separate submittal shall have its own transmittal and cover letter. Submittals which contain different specification section systems bound together shall be returned un-reviewed for re-submittal.

1.12 QUALITY ASSURANCE

A. Acceptable Manufacturers

1. The Engineer’s design for each product is based on the manufacturer listed in the schedule or shown on the drawings. In Part 2 of some technical specifications, other manufacturers are listed as being acceptable. The listing of a manufacturer as acceptable does not imply automatic approval. It is the sole responsibility of the Contractor to ensure that any submittals made are for products that meet or exceed the specifications included herein. These are acceptable only if, as a minimum, they:

   a. Meet all performance criteria listed in the schedules and outlined in the specification.
   b. Have identical operating characteristics to those called for in the specification. For example, a two-post equipment rack will not be acceptable if a four-post model is specified.
   c. Fit within the available space it was designed for, including space for maintenance and component removal, with no modification to either

the space or the product. Clearances to walls, ceilings and other equipment will be at least equal to those shown on the design drawings. The fact that a manufacturer's name appears as acceptable shall not be taken to mean that the Engineer has determined that the manufacturer's products will fit within the available space - this determination is solely the responsibility of the contractor.

d. Products must adhere to all architectural considerations including but not limited to: being of the same color as the product scheduled or specified, fitting within architectural enclosures and details, and for diffusers, lighting and plumbing fixtures - being the same size and of the same physical appearance as scheduled or specified products.

B. All equipment shall be labeled or listed by the National Board of Underwriters Laboratories (U.L.) or other recognized listing/testing agency where such labeling or listing exists for such material.

C. All technology components, devices and accessories shall be listed and labeled as defined in the California Electrical Code (CEC), by a testing agency acceptable to authorities having jurisdiction, and marked for intended use. Skid-mounted or packaged assemblies shall be listed and labeled as an assembly, not just the individual components.

D. Work shall be installed in accordance with BICSI, IEEE, ANSI, and TIA standards.

1.13 UTILITY CHARGES

A. Include utility fees and charges for any temporary voice, data and CATV services.

B. Include utility fees and charges for any required work by the voice, data and CATV service providers for the completion of the project.

C. Utility costs for permanent service shall be paid by the Owner.

1.14 TEMPORARY/ CONTINUITY OF UTILITY SERVICES

A. Refer to Division 1 - General Requirements, regarding specific requirements.

B. Provide temporary services where project construction schedule requires extended shutdowns of existing equipment and/or systems. Temporary services include the necessary equipment and/or systems to maintain continuity of services. Extended shutdowns are interruptions of existing services for a period of time longer than that acceptable to the Owner.

C. Do not interrupt existing utility services without written Owner's approval.

D. Schedule interruptions in advance, according to Owner's instructions. Submit, in writing, with request for interruption, methods proposed to minimize length of interruption.

E. Interruptions shall be scheduled at such times of day and work so that they have minimal impact on Owner's operations.

F. Contractor shall coordinate any shutdowns of existing systems as follows:

1. Give proper notice to Owner when making shutdowns; a minimum of fourteen full days is required.
2. Minimize timeline of shutdowns of any system.
3. Provide temporary services where required and perform shutdowns and tie ins at a time convenient to Owner.
4. Contractor shall be responsible for completing and filing the Owner's shutdown notice questionnaire.
5. Perform required survey and inspection work required by the notice for shutdown.

G. Provide all necessary material, tools, and labor as required for the provisions of temporary services.

H. Include premium time work associated with interruptions of services and/or shutdowns as necessary to avoid disruption to Owner's operations.

I. For communications work associated with any service provider, coordinate with the appropriate service provider.

J. Complete the following form, indicating what is being included as part of this bid, and this project.

K. For work involving an independent utility company (i.e., non-owner provided utility), Contractor shall coordinate directly with the utility provider all aspects of related work, including shutdowns, tie-ins, capacity impacts, etc.

1.15 DELIVERY, STORAGE, AND HANDLING

A. Protect equipment/materials from damage during shipping, storage, handling, and installation. Delivery equipment/materials to the site in manufacturer’s original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

B. The Contractor shall provide for enclosed storage, when equipment/materials are stored on-site and prior to building “dry-in”, to prevent any damage resulting from inclement weather or construction traffic. Specialties shall not be stored outdoors.

C. Equipment/materials, stored or installed, found to be damaged shall be replaced with new by the Contractor, to the satisfaction of the Owner and at no additional

expense. Do not store equipment with PVC material with exposure to direct sunlight.

D. Equipment exposed to weather during shipping and/or storage on site shall be plastic shrink-wrapped by the manufacturer to prevent damage due to weather and road debris during transportation and thereafter while in storage awaiting installation.

E. Prevent dirt and construction debris from accumulating inside equipment (including pipe and conduit, ductwork, fittings, etc.).

F. Equipment/materials shall be handled and installed in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 CEILING ACCESS AND ACCESS PANELS

A. Access panels are generally not shown on the drawings, but they are required to be provided by Contractor.

B. Access panels shall be of size required to provide adequate access to equipment. Minimum size shall be 12" X 12" for hand access or 24" X 24" for body access. Minimum 16-gauge frame, not less than 18-gauge hinged door panel. Door locks shall be screwdriver operated for panels in general location applications and shall be key locked for public area applications.

C. Furnish access panels for installation under other Sections valves or other items installed under this Division require access and are concealed in floor, wall, furred space or above ceiling. Access panels shall be by Milcor, Knapp, Nystorm or Inland Steel; coordinate selection with other Sections supplying similar access panels. Color of panel shall be selected by the Architect.

D. Panels shall include concealed hinges, cam type locking devices, and shall have a frame border type necessary for the particular wall or ceiling construction in which they are installed. Access panels shall be flush mounted, recessed frame type units. Access panels shall be prime coated steel, for field painting for general applications and stainless steel for use in toilet rooms, shower rooms, and similar wet locations.

E. Access panels shall have same fire rating classification as surface penetrated. Rated access panels must have U.L. Label.

2.2 FLASHING MATERIALS

A. All piping, conduit and equipment supports through roofs shall be flashed. Flashing materials and methods shall be in accordance to the roof manufacturer's and Division 07 requirements.

PART 3 - EXECUTION

3.1 PRE-BID SITE VISIT

A. Before submitting bid, visit and carefully examine site to identify existing conditions and difficulties that will affect work of Division 27. No extra payment will be allowed for additional work caused by unfamiliarity with site conditions that are visible or readily construed by an experienced observer.

B. The Low Voltage Contractor shall visit job site to familiarize himself with the specific location of the new equipment installations in existing areas, to ensure there is adequate access for the installation of equipment. All entries, pathways, corridors, stairwells, etc., that may be used to install equipment shall be investigated. All existing conditions and potential obstructions that may impede access and installation shall be addressed prior to equipment purchasing/ordering.

C. The documentation of existing conditions was derived from As-Built documents and are in part unverified. Actual existing conditions shall be verified prior to commencement of work.

3.2 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

F. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions,

ceilings, and floors at pipe, conduit and wiring penetrations. Seal penetrations with fire- and smoke-stop materials. Refer to Division 07 for firestopping and fill materials.

G. Waterproof Penetrations: Maintain integrity of waterproof roof, wall and floor penetrations for pipe, conduit, and equipment support penetrations. Seal penetrations with waterproof materials with clamps, sleeves, flashings, pipe boots and/or pipe curb assemblies as detailed or specified. Refer to Division 07 for waterproofing methods and materials when not specified in this section.

3.3 FIREPROOFING

A. Clips, hangers, clamps, supports and other attachments to surfaces to be fireproofed shall be installed, insofar as possible, prior to start of spray fiber work.

B. Piping and other items which would interfere with proper application of fireproofing shall be installed after completion of spray fiber work.

C. Patching and repairing of fireproofing due to cutting or damaging to fireproofing during course of work specified under this Section shall be performed by installer of fireproofing and paid for by trade responsible for damage and shall not constitute grounds for extra cost to Owner.

3.4 INSTALLATION ONLY ITEMS

A. Where this contractor is required to install items which he does not purchase, he shall coordinate their delivery and be responsible for their unloading from delivery vehicles and for their safe handling and field storage up to the time of installation. This contractor shall be responsible for:

1. Any necessary field assembly and internal connections, as well as mounting in place of the items, including the purchase and installation of all dunnage supporting members and fastenings necessary to adapt them to architectural and structural conditions.
2. Their connection to building systems including the purchase and installation of all terminating fittings necessary to adapt and connect them to the building systems.

B. This Contractor shall carefully examine such items upon delivery. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of work of this Contractor will be considered only if presented in writing within one week of their date of delivery. Unless such claims have been submitted, this Contractor shall be fully responsible for the complete reconditioning or replacement of the damaged items.

3.5 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.

G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pathway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pathway or cable and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 CLEANING AND PAINTING

A. Rubbish resulting from this work shall be removed and disposed of on a daily basis in a manner as to be acceptable to the Architect.

B. The Low Voltage Contractor shall clean exposed work and equipment, the interior and exterior of cabinets and pull boxes, etc., and remove rubbish and debris resulting from the work.

C. Where painted surfaces of equipment have been damaged or rusted during construction, the Low Voltage Contractor shall repair and paint to match original finish.

D. Clean other equipment indicated in other sections of the specification for specific equipment.

E. Cleaning shall be performed prior to system start-up.

F. Equipment

1. After completion of project, clean the exterior surface of all equipment, including concrete residue, dirt, paint residue, etc.

3.8 OWNER TRAINING

A. As part of this contract, the contractor shall include all labor and materials to train the building Owner on the electrical systems installed. The contractor shall be responsible for video and audio taping of all Owner training.

B. Owner training shall adhere to the training specified in each Division 27 Specification Section.

C. In general, training shall cover all aspects of the operation and human interface with the given system. Training shall include, but not be limited to:

1. General description of the system and operating intent.

2. Review and demonstration of all adjustments and programming available to the customer.
3. Review of all system display screens and annunciation functions, both audible and visual.
4. Review and demonstration of all required and recommended periodic system/equipment maintenance. Review shall include all required lockout and tagging procedures.
5. Refer to individual specification sections for additional requirements associated with Owner training.

3.9 COMMISSIONING

A. The Commissioning Authority will be Owner furnished and under direct contract with the Owner. That is, the General Contractor and this subcontractor's bid price shall not include the services of the Commissioning Authority but shall include costs for coordination testing, Contractor commissioning, etc.

3.10 CONTAINMENT ROOM SEALING REQUIREMENTS

A. General

1. Work that penetrates or is mounted on ceilings, walls, floors or other surfaces throughout containment rooms shall be sealed as outlined below in addition to sealing specified elsewhere in the Specifications.
2. Completely seal the perimeter joints around all insulated and uninsulated penetrations and surface-mounted items.

B. Products

1. Acceptable sealant materials shall be products that conform to ASTM C920 "Specifications for Elastomeric Joint Sealants". Sealant shall adhere to substrates and maintain seal under normal expected movements of substrates.
2. Sealant specified herein shall be 732-RTV silicone rubber as manufactured by Dow Chemical Co. or equivalent by GE. Color shall be clear.

C. Installation

1. Preparation, priming (as applicable), application, curing and protection of the sealant shall be in conformance with the recommendations of the sealant manufacturer.
2. If necessary, fill voids with backer rods as recommended by the sealant manufacturer.
3. Mask edges of exposed joints if required to make neat joints and prevent excessive misplacement of sealant onto exposed surfaces adjacent to joints.
4. Perform sealant work after adjacent painting work is complete and dry.

5. Sealant shall be free of voids, be applied in one continuous bead and be tooled concave and smooth.

END OF SECTION

SECTION 27 05 10 - SELECTIVE COMMUNICATIONS DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:

1. Disconnection of communications to selected portions of building or structure.
2. Demolition and removal of selected communications and low voltage components.
3. Salvage of existing items to be reused or recycled.

B. Related Requirements:

1. Division 01 Section "Cutting and Patching."
2. Division 02 Section “Selective Structure Demolition” for sequencing and scheduling procedures and requirements for demolition activities.
3. Division 26 Section 26 05 10 “Selective Electrical Demolition” for coordination with electrical contractor.

1.3 JOB CONDITIONS

A. Perform all demolition as needed to accomplish new work.

B. Do not rely solely on communications and low voltage drawings to determine extent of general construction demolition. Refer to architectural demolition plans for the exact extent of general construction demolition required by this contract.

C. This Contractor is responsible for all charges, fees etc. incurred as a result of the communications and low voltage portion of the demolition.

D. Prior to demolition or alteration of structures, the following shall be accomplished:

1. Review available record documents of the existing construction. Owner does not guarantee that existing conditions are same as those indicated in record documents.
2. Coordinate sequencing with Owner and other Contractors.
3. Coordinate means to separate construction zones from non-renovated zones to prevent the spread of dust, fumes and debris.
4. Coordinate means to provide exhaust and makeup air to maintain the construction zone at an adequate negative pressure to contain all construction dust and fumes.

5. Except as noted otherwise, remove from the premises, all materials and equipment removed in the demolition work.
6. Equipment noted to be removed and turned over to the Owner, shall be delivered to the Owner at a place and time he so designates.
7. Where the materials are to be turned over to the Owner or reused and installed by the Contractor, it shall be the Contractor's responsibility to maintain the condition of the materials and equipment equal to that existing before work began. Damaged materials or equipment shall be repaired or replaced at no additional cost to the Owner.
8. Survey and record condition of existing facilities to remain in place that may be affected by demolition operations. After demolition operations are completed, survey conditions again and restore existing facilities to their pre-demolition condition, at no additional cost to Owner.
9. Salvage equipment scheduled for reuse in new work or scheduled to be delivered to Owner's storage facility.

PART 2 - PRODUCTS
Not used.

PART 3 - EXECUTION

3.1 PREPARATION

A. Survey existing conditions and correlate with requirements indicated to determine the extent of selective demolition required.

B. Refer to demolition drawings of other trades. Where control panels, and other pieces of equipment that have communications connections are being removed, include the disconnection and removal of associated structured cabling, outlets, and loose control equipment in this contract.

C. Protect existing work to remain in place, to be reused, or to remain property of Owner.

D. Protect existing services and utilities.

E. Disconnect communications systems in walls floors and ceilings scheduled for removal.

F. Coordinate utility service outages with serving utility company.

G. Provide temporary structured cabling and connections to maintain existing equipment and outlets in service during construction.

H. Existing Communications Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switch overs and connections. Obtain permission from owner at least 24 hours before partially or

completely disabling system. Minimize outage duration. [**Make temporary connections to maintain service to areas adjacent to work area.**]

3.2 PHASING AND INSTALLATION OF NOW OR TEMPORARY COMMUNICATIONS WORK

A. Refer to phasing plan and cable schedule for exact requirements to maintain low voltage services throughout demolition.

B. Refer to new work plans and specifications for cabling and equipment installation requirements.

C. All system downtime and service interruptions shall be coordinated with owner.

D. New cable pathways installed to maintain services throughout construction shall be installed such that they are outside the construction limit of work or sufficiently protected throughout the duration of demolition and construction.

3.3 DEMOLITION AND EXTENSION OF EXISTING COMMUNICATIONS WORK

A. Beginning of demolition means installer accepts existing conditions.

B. Existing communications equipment in conflict with new construction shall be removed and/or relocated as indicated on the drawings, as directed or needed. This Contractor shall remove all communications equipment released from service as a result of construction, and no equipment removed shall be reused, except as specifically directed on the drawings or elsewhere herein. All mechanical components shall be stored on site for Owner assessment. Any components not retained by the Owner shall be removed by the contractor. Properly dispose or remove from site any items not retained by Owner.

C. Any existing services or equipment not shown on the drawings and which are logically expected to be continued in service and which may be interrupted or disturbed during construction, shall be reconnected in an approved manner. Provide temporary phone connections, etc., as needed to prevent interruption of service to occupied areas caused by demolition operations. In addition, any conduit, wiring, fixtures, or equipment which may require relocation or rerouting as a result of construction, shall be considered a part of the work of this section and shall be done by this Contractor with no additional compensation, provided that the referenced relocation is discernable from the pre-bid review of the site, and associated documents.

D. Verify that abandoned wiring and equipment serve only abandoned facilities.

E. Report discrepancies to Architect before disturbing existing installation.

F. Unterminate, demolish, and remove structured cable systems, equipment, raceways, wiring, and components indicated to be removed.

G. Conduit to Be Removed: Remove portion of conduit indicated or specified to be removed. In general, all empty raceways and associated supporting devices shall be removed back to nearest junction box, panel, cabinet/rack, or other similar enclosure.

H. Cable to be Removed: Unless specifically stated elsewhere, all un-terminated cables shall be removed back to source.

I. Equipment to be Removed, Including Panels, Cabinets, Racks and Rack-Mounted Equipment: De-energize, disconnect associated raceways and wiring, and remove equipment.

J. Equipment to Be Removed and Reinstalled: De-energize, disconnect associated raceways and wiring, and remove equipment. Clean equipment and store where appropriate, reinstall, reconnect, and make equipment operational. Test equipment and associated components in accordance with the appropriate specification section.

K. Equipment to Be Removed and Salvaged: De-energize, disconnect associated raceways and wiring, and move equipment to on site storage area as designated by the Owner.

L. Any unused conduit openings in junction boxes, panels, pull boxes, or other similar enclosures shall be covered in a code approved manner.

M. Update any structured cable labeling schemes and rack and panel identification nameplates to reflect changes in the status resulting from demolition.

N. Notify Architect of location and extent of existing piping, conduit, OR equipment that interferes with new construction. In coordination with and with approval of Architect, relocate conduit and equipment to permit new work to be provided as required by Contract Documents. Remove non-functioning and abandoned conduit and equipment as directed by Architect. Dispose of or store items as requested by Architect.

O. Outlet boxes being abandoned in existing walls in remodeled areas shall have opening patched to match existing wall finish. Blank covers are not acceptable.

P. Maintain access to existing structured cabling installations that remain active. Modify installation or provide access panel as appropriate.

Q. Maintain continuity of cabling that remain in service.

R. Existing conduit and wiring in remodeled area that is not being removed, but which will be in conflict with new HVAC duct work being installed, shall be rerouted as required.

S. When existing ductwork, piping, or related equipment in remodeled areas prevents the installation of other work, remove and reinstall existing materials, making necessary modifications and transitions to coordinate with other trades.

3.4 CLEANING AND REPAIR

A. Clean existing materials and equipment which remain or are to be reused. Report damage or defects to Architect

B. Existing Panels, Racks and Cabinets: Clean exposed surfaces and check tightness of cable connections. Provide cover plates for vacant positions.

C. If equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

D. Repair adjacent construction and finishes damage during demolition and extension work.

END OF SECTION

SECTION 27 05 26 – GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Grounding conductors.
2. Grounding connectors.
3. Grounding busbars.
4. Grounding rods.
5. Grounding labeling.

1.3 DEFINITIONS

A. BCT: Bonding Conductor for Telecommunications.

B. BICSI: Building Industry Consulting Service International.

C. TGB: Telecommunications Grounding Busbar: The interface to the building telecommunications grounding system generally located in the telecommunications room or equipment room. A common point of connection for telecommunications system and equipment bonding to ground and located in the telecommunications room or equipment room.

D. TMGB: Telecommunications Main Grounding Busbar: A busbar placed in a convenient and accessible location and bonded, by means of the bonding conductor for telecommunications, to the building service equipment (power) ground.

E. Service Provider: The operator of a service that provides telecommunications transmission delivered over access provider facilities.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1. Product Data: For each conductor and cable indicating lead content.

C. Shop Drawings: For communications equipment room signal reference grid. Include plans, elevations, sections, details, and attachments to other work.

1.5 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:

1. Ground rods.
2. Ground and roof rings.
3. BCT, TMGB, TGBs, and routing of their bonding conductors.

B. Qualification Data: For Installer, installation supervisor, and field inspector.

C. Qualification Data: For testing agency and testing agency's field supervisor.

D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

a. Result of the ground-resistance test, measured at the point of BCT connection.
b. Result of the bonding-resistance test at each TGB and its nearest grounding electrode.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Installation Supervision: Installation shall be under the direct supervision of ITS Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
2. Field Inspector: Currently registered by BICSI as a designer RCDD to perform the on-site inspection.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined inthe California Electric Code (CEC), by a qualified testing agency, and marked for intended location and application.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

C. Comply with TIA-607-D.

2.2 CONDUCTORS

A. Comply with UL 486A-486B.

B. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.

1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
2. Cable Tray Equipment Grounding Wire: No. 6 AWG.
1. Lead Content: Less than 300 parts per million.

C. Cable Tray Grounding Jumper:

1. Not smaller than No. 6 AWG and not longer than 12 inches. If jumper is a wire, it shall have a crimped grounding lug with two holes and long barrel for two crimps. If jumper is a flexible braid, it shall have a one-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.
2. Not smaller than No. 10 AWG and not longer than 12 inches. If jumper is a wire, it shall have a crimped grounding lug with one hole and standard barrel for one crimp. If jumper is a flexible braid, it shall have a one- or two-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.

D. Bare Copper Conductors:

1. Solid Conductors: ASTM B3.
2. Stranded Conductors: ASTM B8.
3. Tinned Conductors: ASTM B33.
4. Bonding Cable: 28 kcmils, 14 strands of No. 17 AWG conductor, and 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.3 CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Chatsworth Products, Inc.
2. Erico Eritech
3. Hubbell Incorporated
4. Panduit Corp.

B. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

C. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.

1. Electroplated tinned copper, C and H shaped.

D. Signal Reference Grid Connectors: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.

E. Busbar Connectors: Cast silicon bronze, solderless compression or exothermic-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.

F. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING BUSBARS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Chatsworth Products, Inc.
2. Erico Eritech
3. Ortronics, A Legrand Company
4. Panduit

B. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches in cross section, length as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with TIA-607-D.

1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide a 4-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.

3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

C. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with TIA-607-D.

1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

D. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-607-D. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
3. Rack-Mounted Vertical Busbar: 72 or 36 inches long, with stainless-steel or copper-plated hardware for attachment to the rack.

2.5 GROUND RODS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Harger Lightning & Grounding.
2. TE Connectivity Ltd.

B. Ground Rods: Copper-clad steel; 5/8 by 96 inches in diameter.

2.6 IDENTIFICATION

A. Comply with requirements for identification products in Section 27 05 53 "Identification for Communications Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.

B. Inspect the test results of the ac grounding system measured at the point of BCT connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.

B. Comply with NECA 1.

C. Comply with TIA-607-D.

3.3 APPLICATION

A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.

B. Underground Grounding Conductors: Install bare copper conductor, No. 2 AWG minimum.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

D. Conductor Support:

1. Secure grounding and bonding conductors at intervals of not less than 36 inches.

E. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
2. Install without splices.
3. Support at not more than 36-inch intervals.
4. Install grounding and bonding conductors in 3/4-inch PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.

a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 27 05 28 "Pathways for Communications Systems," and bond both ends of the conduit to a TGB.

3.4 GROUNDING ELECTRODE SYSTEM

A. The BCT between the TMGB and the ac service equipment ground shall not be smaller than No. 3/0 AWG.

3.5 GROUNDING BUSBARS

A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches minimum from wall, 12 inches above finished floor unless otherwise indicated.

B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.6 CONNECTIONS

A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.

B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:

1. Use crimping tool and the die specific to the connector.
2. Pre-twist the conductor.

3. Apply an antioxidant compound to all bolted and compression connections.

D. Primary Protector: Bond to the TMGB with insulated bonding conductor.

E. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.

F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors.

G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.

H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.

I. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA-568-C.1 and TIA-568-C.2 when grounding shielded balanced twisted-pair cables.

J. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

3.7 IDENTIFICATION

A. Labels shall be preprinted or computer-printed type.

1. Label TMGB(s) with "fs-TMGB," where "fs" is the telecommunications space identifier for the space containing the TMGB.
2. Label TGB(s) with "fs-TGB," where "fs" is the telecommunications space identifier for the space containing the TGB.
3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.

    a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.

3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.

    a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB and in each TGB. Maximum acceptable ac current level is 1 A.

D. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Architect promptly and include recommendations to reduce ground resistance.

E. Grounding system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION

SECTION 27 05 28 – PATHWAYS FOR COMMUNICATION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Conduits and fittings.
2. Optical-fiber-cable pathways and fittings.
3. Wireways and auxiliary gutters.
4. Surface pathways.
5. Tele-power poles.
6. Hooks.
7. Boxes, enclosures, and cabinets.
8. Exterior handholes/boxes.
9. Cable trays, hangers, supports, and fittings.
10. Sleeves and sealants

B. Related Requirements:

1. Division 07 Section "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.
2. Division 26 Section “Grounding and Bonding for Electrical Systems” for grounding and bonding requirements based on pathway type.
3. Division 26 Section “Cable Trays for Electrical Systems” for cable trays and accessories serving electrical systems.
4. Division 26 Section “Raceways and Boxes for Electrical Systems”.
5. Division 26 Section “Underfloor Raceways for Electrical Systems”.
6. Division 26 Section “Underground Ducts and Raceways for Electrical Systems”.
7. Division 26 Section “Sleeves and Sleeve Seals for Electrical Raceways and Cabling”.
8. Division 27 Section “Seismic Controls for Communications System” for products and installation requirements necessary for compliance with seismic criteria.
9. Division 27 Section “Grounding and Bonding for Communications Systems” for grounding and bonding requirements based on pathway type.

10. Division 27 Section “Communications Equipment Room Fittings” for ladder tray accessories serving communications equipment rooms.

1.3 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. EMT: Electrical metal tubing.

C. GRC: Galvanized rigid conduit.

D. IMC: Intermediate metal conduit.

E. RMC: Rigid metal conduit.

F. RNC: Rigid nonmetallic conduit.

G. RTRC: Reinforced thermosetting resin conduit.

H. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Provide manufacturer’s catalog information showing dimensions, colors, and configurations.
2. Submittals shall include all items called for in PART 2 – PRODUCTS of this document and the manufacturers cut sheets for the following:

a. Continuous and non-continuous cable pathway and fittings
b. All boxes and enclosures.

B. Shop Drawings:

1. For custom enclosures and boxes. Include plans, elevations, sections, and attachment details.
2. Cable pathway (continuous and non-continuous) layout, showing cable pathway route to scale, with relationship between the pathway and adjacent structural, electrical, and mechanical elements. Include the following:

a. Vertical and horizontal offsets and transitions.
b. Clearances for access above and to side of cable pathways.
c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.

d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from the applicable contractors involved:

1. Structural members in paths of pathway groups with common supports.
2. HVAC, plumbing, fire protection, and electrical items and architectural features in paths of conduit groups with common supports.
3. Underground ducts, piping, and structures in location of underground enclosures and handholes.

B. Qualification Data: For [Installer], [qualified layout technician and installation supervisor.]

C. Seismic Qualification Certificates: Submit documentation on seismic properties for pathway tray, ladder rack, enclosures, cabinets, equipment racks and their mounting provisions including those for internal components from manufacturer to the structural engineer. Coordinate exact submittal requirements with the structural specifications.

D. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit; a Tyco International Ltd. Co.
3. O-Z/Gedney; a brand of EGS Electrical Group.
4. Robroy Industries.
5. Southwire Company.
6. Thomas & Betts Corporation.

B. Metal Conduit:

1. EMT: Comply with ANSI C80.3 and UL 797.
2. FMC: Comply with UL 1; zinc-coated steel or aluminum.
3. GRC: Comply with ANSI C80.1 and UL 6.

4. IMC: Comply with ANSI C80.6 and UL 1242.
5. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
6. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

   a. Comply with NEMA RN 1.
   b. Coating Thickness: 0.040 inch, minimum.

C. Metal Fittings:

1. Comply with NEMA FB 1 and UL 514B.
2. Listed and labeled for type of conduit, location, and use.
3. Hazardous (Classified) Locations: Comply with UL 1203.
4. Fittings for EMT:

   a. Conduit Fittings for Indoor Wet Locations or Exterior: Steel insulated throat, compression, UL listed rain-tight.
   b. Fittings for dry locations: Steel insulated throat, set-screw or compression type (Die-cast fittings will not be accepted).

5. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
6. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.

D. Joint Compound for IMC and GRC: Approved, as defined in applicable electrical code, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AFC Cable Systems, Inc.
2. Anamet Electrical, Inc.
3. Arnco Corporation.
4. CANTEX Inc.
5. CertainTeed Corp.
6. Champion Fiberglass
7. Condux International, Inc.
8. Electri-Flex Company.
9. Kraloy.
10. Lamson & Sessions; Carlon Electrical Products.
11. Niedax-Kleinhuis USA, Inc.
12. RACO; a Hubbell company.

13. Thomas & Betts Corporation.

B. Nonmetallic Conduit:

1. Fiberglass:

a. Comply with NEMA TC 14.
b. Comply with UL 2515 for aboveground raceways.
c. Comply with UL 2420 for belowground raceways.

2. ENT: Comply with NEMA TC 13 and UL 1653.
3. RNC: Type EPC-40-PVC, [**Type EPC-80-PVC**], complying with NEMA TC 2 and UL 651 unless otherwise indicated.
4. LFNC: Comply with UL 1660.

C. Nonmetallic Fittings:

1. Fittings, General: Listed and labeled for type of conduit, location, and use.
2. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

a. Fittings for LFNC: Comply with UL 514B.

3. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

A. Description: Comply with UL 2024; flexible-type pathway with a circular cross section, approved for [**plenum**] [**riser**] [**or**] [**general-use**] installation unless otherwise indicated.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Alpha Wire.
2. Carlon; a brand of Thomas & Betts Corporation.
3. Dura-Line.
4. Endot Industries Inc.
5. IPEX USA LLC.

C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with TIA-569-D.

2.4 SURFACE PATHWAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Panduit

2. Wiremold; Legrand

B. Material: [Galvanized steel with snap-on covers, complying with UL 5.][Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC.]

C. Finish: [Manufacturer's standard enamel finish in color selected by Architect.][Prime coated, ready for field painting].

D. Finish: Texture and color selected by Architect from [**manufacturer's standard**][**custom**] colors.

E. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

F. Comply with TIA-569-D.

2.5 TELE-POWER POLES:

A. Description: Prefabricated, finished metal pole with prewired power and communications outlets.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Panduit

2. Wiremold; Legrand

C. Material: [Galvanized steel with ivory baked-enamel finish][Aluminum with clear anodized finish].

D. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

E. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

F. Comply with TIA-569-D.

2.6 NON-CONTINUOUS CABLE SUPPORT (J-HOOKS)

A. Acceptable Manufacturers

1. Chatsworth Products, Inc.
2. Cooper B-Line
3. ERICO
4. Snake Tray by Cable Management Solutions, Inc.

B. General

1. J-hooks shall have flared edges to prevent damage while installing cables.
2. J-hooks shall have an electro-galvanized or G 60 finish and shall be rated for indoor use for non-corrosive environments.
3. J-hook cable supports shall provide a bearing surface of sufficient width to comply with the bend radii of high-performance cables.

C. Size

1. J-hooks shall have a minimum bearing surface of 1 ¾ inches.
2. Follow Manufactures recommendations for allowable fill capacity for each size J-hook cable support.

D. Support

1. J-hooks mounted to studs and stud walls: When mounting J-hooks to stud walls the J-hook shall be connected directly to the stud, the J-hook shall not be supported by the wall covering/ finish alone.
2. J-hooks supported by threaded rod: Refer to manufacturer's suggested attachment method to attach J-hook to threaded rod using standard nuts.
3. J-hooks supported by the use of beam attachments shall be:

a. Factory or jobsite assembled.
b. Hammer or Screw-On, C & Z perlin, Concrete or Joist support type.
c. Use manufacturer approved attachment method.

2.7 BOXES, ENCLOSURES, AND CABINETS

A. Description: Enclosures for communications.

B. Acceptable Manufacturers:

1. Cooper Technologies Company; Cooper Crouse-Hinds.
2. Hoffman; a Pentair company.
3. Hubbell Incorporated; Killark Division.
4. RACO; a Hubbell company.
5. Wiremold / Legrand.

C. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-D.
2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
4. Device Box Dimensions: **[4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep)]**[**<Insert other dimension>**].
5. Gangable boxes are [**allowed**][**prohibited**].

D. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

E. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, [**ferrous alloy**] [**aluminum**], Type FD, with gasketed cover.

F. Metal Floor Boxes:

1. Material: [Cast metal] [or] [sheet metal].
2. Type: [Fully adjustable] [Semi-adjustable].
3. Shape: Rectangular.
4. Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Nonmetallic Floor Boxes: Nonadjustable, [**round**] [**rectangular**].

1. Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

I. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, [**cast aluminum**] [**galvanized, cast iron**] with gasketed cover.

J. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, [**Type 1**] [**Type 3R**] [**Type 4**] [**Type 12**] <**Insert type**>, with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures:

a. Material: [Plastic] [Fiberglass].
b. Finished inside with radio-frequency-resistant paint.

3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

L. Cabinets:

1. NEMA 250, [**Type 1**] [**Type 3R**] [**Type 12**] <**Insert type**> galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.8 POLYMER-CONCRETE HANDHOLES

A. Description: Molded of sand and aggregate; bound together with polymer resin; and reinforced with steel, fiberglass, or a combination of the two.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Oldcastle Infrastructure.
2. Quazite.

C. General Requirements for Polymer Concrete Handholes:

1. Boxes and handholes for use in underground systems shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
3. Comply with TIA-569-D[**and SCTE 77**].

D. Configuration: Designed for flush burial with [**open**] [**closed**] [**integral closed**] bottom unless otherwise indicated.

E. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.

1. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
2. Cover Legend: Molded lettering, [**"COMMUNICATIONS"**] <**Insert legend**>.

F. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

G. Handholes [**12 Inches Wide by 24 Inches Long**] <**Insert dimensions**> and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.9 FIBERGLASS HANDHOLES AND BOXES

A. Description: Molded of fiberglass-reinforced polyester resin, with frame and covers of [**polymer concrete**] [**reinforced concrete**] [**cast iron**] [**hot-dip galvanized-steel diamond plate**] [**fiberglass**].

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Oldcastle Infrastructure.
2. Quazite.

C. General Requirements for Fiberglass Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
3. Comply with TIA-569-D[**and SCTE 77**].

D. Color of Frame and Cover: [**Gray**] [**Green**].

E. Configuration: Designed for flush burial with [**open**] [**closed**] [**integral closed**] bottom unless otherwise indicated.

F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.

G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

H. Cover Legend: Molded lettering, [**"COMMUNICATIONS"**] <**Insert legend**>.

I. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

J. Handholes [**12 Inches Wide by 24 Inches Long**] <**Insert dimensions**> and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.10 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

2.11 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design cable tray supports and seismic bracing.

B. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**] <**Insert requirement**>.

1. The term "withstand" means "the cable trays will remain in place without separation of any parts when subjected to the seismic forces specified."
2. Component Importance Factor: [**1.5**] [**1.0**].
3. <Insert requirements for Component Amplification Factor and Component Response Modification Factor>.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.

1. Temperature Change: [**120 deg F**, ambient; **180 deg F**, material surfaces] <Insert temperature change>.

2.12 GENERAL REQUIREMENTS FOR CABLE TRAYS

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.

1. Source Limitations: Obtain cable trays and components from single manufacturer.

B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

C. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:

1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.13 LADDER CABLE TRAY

A. Acceptable Manufacturers

1. Chatsworth Products
2. Cooper B-line
3. G S Metals
4. Snake Tray by Cable Management Solutions, Inc.
5. Wiremold

B. Description:

1. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.
2. Width: [**12 inches**][**24 inches**][**<Insert Width>**] unless otherwise indicated on Drawings.
3. Minimum Usable Load Depth: [**1 inches**][**<Insert Depth>**].
4. Rung Spacing: [**9 inches**] [**12 inches**] o.c.
5. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.
6. Minimum Cable-Bearing Surface for Rungs: 7/8-inch width with radius edges.
7. No portion of the rungs shall protrude below the bottom plane of side rails.
8. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
9. Fitting Minimum Radius: 12 inches.
10. Class Designation: Comply with NEMA VE 1, [Class 5AA] [Class 5A] [Class 8AA] [Class 8A] [Class 10AA] [Class 10A] [Class 12AA] [Class 12A] [Class 20AA] [Class 20A] <Insert designation>.
11. Splicing Assemblies: Bolted type using serrated flange locknuts.
12. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
13. Covers: [**Solid**] [**Louvered**] [**Ventilated-hat**] [**2-in-3 pitch**] type made of same materials and with same finishes as cable tray.

C. Materials and Finishes:

1. Steel:

   a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of [**ASTM A1011/A1011M, SS, Grade 33**] [**ASTM A1008/A1008M, Grade 33, Type 2**].
   b. Steel Tray Splice Plates: ASTM A1011/A1011M, HSLAS, Grade 50, Class 1.
   c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A510/A510M, Grade 1008.
   d. Finish: Hot-dip galvanized after fabrication, complying with ASTM A123/A123M, Class B2.

      1) Hardware: [Galvanized, ASTM B633] [Chromium-zinc plated, ASTM F1136] [Stainless steel, Type 316].

   e. Finish: Hot-dip galvanized after fabrication, complying with ASTM A653/A653M, G90.

      1) Hardware: [Galvanized, ASTM B633] [Chromium-zinc plated, ASTM F1136].

   f. Finish: Electrogalvanized after fabrication, complying with ASTM B633.

      1) Hardware: Galvanized, ASTM B633.

   g. Finish: [Epoxy-resin] [Powder-coat enamel] paint.

      1) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
      2) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
      3) Epoxy-Resin Topcoat: Epoxy, cold-cured gloss, MPI# 77.
      4) Hardware: [Chromium-zinc plated, ASTM F1136] [Stainless steel, Type 316, ASTM F593 and ASTM F594].

   h. Finish: Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware according to ASTM F1136.
   i. Finish: Black oxide finish for support accessories and miscellaneous hardware according to ASTM D769.
   j. <Insert finish>.

2. Aluminum:

   a. Materials: Alloy 6063-T6 according to ANSI H35.1/H 35.1M for extruded components, and [**Alloy 5052-H32**] [**or**] [**Alloy 6061-T6**] according to ANSI H35.1/H 35.1M for fabricated parts.

b. Hardware: [Chromium-zinc-plated steel, ASTM F1136] [Stainless steel, Type 316, ASTM F593 and ASTM F594].
c. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F593 and ASTM F594.

3. Stainless Steel:

a. Materials: Low-carbon, passivated stainless steel, [**Type 304L**] [**or**] [**Type 316L**], ASTM F593 and ASTM F594.
b. Hardware for Stainless-Steel Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F593 and ASTM F594.

2.14 WIRE-MESH CABLE TRAY

A. Acceptable Manufacturers

1. Cablofil
2. Chatsworth Products
3. Eaton B-line
4. G S Metals
5. Snake Tray by Cable Management Solutions, Inc.
6. WBT, LLC

B. Description:

1. Configuration: [**Galvanized-**] steel wire mesh, complying with NEMA VE 1.
2. Width: [**2 inches**] [**4 inches**] [**6 inches**] [**8 inches**] [**12 inches**] [**16 inches**] [**18 inches**] [**20 inches**] [**24 inches**] unless otherwise indicated on Drawings.
3. Minimum Usable Load Depth: [**1 inch**] [**2 inches**] [**4 inches**] [**6 inches**].
4. Straight Section Lengths: [**10 feet**] [**12 feet**], except where shorter lengths are required to facilitate tray assembly.
5. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
6. Class Designation: Comply with NEMA VE 1, [Class 5AA] [Class 5A] [Class 8AA] [Class 8A] [Class 10AA] [Class 10A] [Class 12AA] [Class 12A] [Class 20AA] [Class 20A] <Insert designation>.
7. Splicing Assemblies: Bolted type using serrated flange locknuts.
8. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

C. Materials and Finishes:

1. Steel:

a. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of [**ASTM A1011/A1011M, SS, Grade 33**] [**ASTM A1008/A1008M, Grade 33, Type 2**].
b. Steel Tray Splice Plates: ASTM A1011/A1011M, HSLAS, Grade 50, Class 1.
c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A510/A510M, Grade 1008.
d. Finish: Hot-dip galvanized after fabrication, complying with ASTM A123/A123M, Class B2.

1) Hardware: [Galvanized, ASTM B633] [Chromium-zinc plated, ASTM F1136] [Stainless steel, Type 316].

e. Finish: Hot-dip galvanized after fabrication, complying with ASTM A653/A653M, G90.

1) Hardware: [Galvanized, ASTM B633] [Chromium-zinc plated, ASTM F1136].

f. Finish: Electrogalvanized after fabrication, complying with ASTM B633.

1) Hardware: Galvanized, ASTM B633.

g. Finish: [Epoxy-resin] [Powder-coat enamel] paint.

1) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
2) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
3) Epoxy-Resin Topcoat: Epoxy, cold-cured gloss, MPI# 77.
4) Hardware: [Chromium-zinc plated, ASTM F1136] [Stainless steel, Type 316, ASTM F593 and ASTM F594].

h. Finish: Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware according to ASTM F1136.
i. Finish: Black oxide finish for support accessories and miscellaneous hardware according to ASTM D769.
j. <Insert finish>.

2.15 TROUGH CABLE TRAY

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cablofil; Legrand North America, LLC.
2. Eaton (B-line).

B. Description:

1. Configuration:

a. A [**flat**] [**corrugated**] bearing surface with a [**solid**] [**ventilated**] bottom contained within two longitudinal side rails, with both edges welded to the side rails complying with NEMA VE 1.
b. Single, formed sheet with a [**solid**] [**ventilated**] bottom, complying with NEMA VE 1.

2. Covers: [**Solid**] [**Louvered**] [**Ventilated-hat**] [**2-in-3 pitch**] type made of same materials and with same finishes as cable tray.
3. Width: [**6 inches**] [**9 inches**] [**12 inches**] [**18 inches**] [**24 inches**] [**30 inches**] [**36 inches**] unless otherwise indicated on Drawings.
4. Minimum Usable Load Depth: [**3 inches**] [**4 inches**] [**5 inches**] [**6 inches**].
5. Straight Section Lengths: [**10 feet**] [**12 feet**] [**20 feet**] [**24 feet**], except where shorter lengths are required to facilitate tray assembly.
6. Fitting Minimum Radius: [**12 inches**] [**24 inches**] [**36 inches**] [**48 inches**].
7. Class Designation: Comply with NEMA VE 1, [Class 5AA] [Class 5A] [Class 8AA] [Class 8A] [Class 10AA] [Class 10A] [Class 12AA] [Class 12A] [Class 20AA] [Class 20A] <Insert designation>.
8. Splicing Assemblies: Bolted type using serrated flange locknuts.
9. Splicing Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
10. Covers: [**Solid**] [**Louvered**] [**Ventilated-hat**] [**2-in-3 pitch**] type made of same materials and with same finishes as cable tray.

C. Materials and Finishes:

1. Steel:

a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of [**ASTM A1011/A1011M, SS, Grade 33**] [**ASTM A1008/A1008M, Grade 33, Type 2**].
b. Steel Tray Splice Plates: ASTM A1011/A1011M, HSLAS, Grade 50, Class 1.
c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A510/A510M, Grade 1008.
d. Finish: Hot-dip galvanized after fabrication complying with ASTM A123/A123M, Class B2.

1) Hardware: [Galvanized, ASTM B633] [Chromium-zinc plated, ASTM F1136] [Stainless steel, Type 316].

e. Finish: Hot-dip mill galvanized before fabrication complying with ASTM A653/A653M, G90.

1) Hardware: [Galvanized, ASTM B633] [Chromium-zinc plated, ASTM F1136].

f. Finish: Electrogalvanized after fabrication, complying with ASTM B633.

1) Hardware: Galvanized, ASTM B633.

g. Finish: [Epoxy-resin] [Powder-coat enamel] paint.

1) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
2) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
3) Epoxy-Resin Topcoat: Epoxy, cold-cured gloss, MPI# 77.
4) Hardware: [Chromium-zinc plated, ASTM F1136] [Stainless steel, Type 316, ASTM F593 and ASTM F594].

h. Finish: Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware according to ASTM F1136.

i. Finish: Black oxide finish for support accessories and miscellaneous hardware according to ASTM D769.

2. Aluminum:

a. Materials: Alloy 6063-T6 according to ANSI H35.1/H 35.1M for extruded components, and [**Alloy 5052-H32**] [**or**] [**Alloy 6061-T6**] according to ANSI H35.1/H 35.1M for fabricated parts.

b. Hardware: [Chromium-zinc-plated steel, ASTM F1136] [Stainless steel, Type 316, ASTM F593 and ASTM F594].

c. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F593 and ASTM F594.

3. Stainless Steel:

a. Materials: Low-carbon, passivated stainless steel, [**Type 304L**] [**or**] [**Type 316L**], ASTM F593 and ASTM F594.

b. Hardware for Stainless-Steel Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F593 and ASTM F594.

2.16 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Barrier Strips: Same materials and finishes as for cable tray.

C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.17 WARNING SIGNS

A. Comply with requirements for identification in Section 27 05 53 "Identification for Communications Systems."

B. Lettering: [**1-1/2-inch-**] <**Insert dimension**> high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."

2.18 SLEEVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. GPT Industries – (Link-Seal)

B. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

C. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

D. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.19 SLEEVE SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. GPT Industries – (Link-Seal)

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable or between pathway and cable.

1. Sealing Elements: EPDM or Nitrile (Buna N) rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Fiber-reinforced plastic or Reinforced Nylon Polymer or Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.20 GROUT

A. Description: Non-shrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.21 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

2.22 FLEXIBLE RACEWAY (INNERDUCT)

A. Acceptable Manufacturers

1. CANTEX Inc

2. Lamson & Sessions; Carlon Electrical Products.
3. Lamson & Sessions: Pyramid Industries.
4. Maxcell
5. RACO; a Hubbell company.
6. Thomas & Betts Corporation.

B. Flexible Raceway shall be **[plenum][riser]** rated.

C. The rating of the flexible raceway shall match the rating of the surrounding environment which it is installed.

D. Flexible raceway shall meet the requirements:

1. NEC Articles 770 and 800 for Telecommunications Cables.
2. Flexible raceway shall be UL Listed under **[UL 1666 Standard for Riser][UL 910 Standard for Plenum]** Application for Optical Fiber Raceway.

E. Flexible raceway shall be provided with a pull (mule) tape routed throughout the raceway containing footage markings.

F. Flexible raceway fitting and accessories shall be manufactured by the same manufacturer as the flexible raceway.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed Conduit: [**GRC**] [**IMC**] [**RNC, Type EPC-40-PVC**] [**RNC, Type EPC-80-PVC**].
2. Concealed Conduit, Aboveground: [**GRC**] [**IMC**] [**EMT**] [**RNC, Type EPC-40-PVC**].
3. Underground Conduit: RNC, [**Type EPC-40-PVC**] [**Type EPC-80-PVC**], [**direct buried**] [**concrete encased**].
4. Boxes and Enclosures, Aboveground: NEMA 250, [**Type 3R**] [**Type 4**].

B. Indoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: [**EMT**] [**or**] [**RNC**].
2. Exposed, Not Subject to Severe Physical Damage: [**EMT**] [**RNC identified for such use**].
3. Exposed and Subject to Severe Physical Damage: [**GRC**] [**IMC**]. Pathway locations include the following:

a. Loading dock.

b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
c. Mechanical rooms.
d. Gymnasiums
e. <**Insert designations of applicable spaces or locations**>.

4. Concealed in Ceilings and Interior Walls and Partitions: [**EMT**] [**RNC, Type EPC-40-PVC**] [**or**] [**innerduct**].
5. Damp or Wet Locations: [**GRC**] [**IMC**].
6. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: [**Plenum-type, optical-fiber-cable pathway**] [**Plenum-type, communications-cable pathway**] [**EMT**] <**Insert pathway type**>.
7. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: [**Riser-type, optical-fiber-cable pathway**] [**Riser-type, communications-cable pathway**] [**EMT**] <**Insert pathway type**>.
8. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: [**General-use, optical-fiber-cable pathway**] [**Riser-type, optical-fiber-cable pathway**] [**Plenum-type, optical-fiber-cable pathway**] [**General-use, communications-cable pathway**] [**Riser-type, communications-cable pathway**] [**Plenum-type, communications-cable pathway**] [**EMT**] <**Insert pathway type**>.
9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 [**stainless steel**] [**nonmetallic**] units in institutional and commercial kitchens and damp or wet locations.

C. Minimum Pathway Size: 3/4-inch trade size for copper and aluminum cables, and 1 inch for optical-fiber cables.

D. Pathway Fittings: Compatible with pathways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use [**set-screw**] [**or**] [**compression**], [**steel**] [**cast-metal**] fittings. Comply with NEMA FB 2.10.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface pathways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds [**120 deg F**] <**Insert temperature**>.

3.2 INSTALLATION

A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:

1. NECA 1.
2. NECA/BICSI 568.
3. TIA-569-D.
4. NECA 101
5. NECA 102.
6. NECA 105.
7. NECA 111.

B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

C. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

D. Comply with requirements in Section 27 05 29 "Hangers and Supports for Communications Systems" for hangers and supports.

E. Comply with requirements in Section 27 05 44 "Sleeves and Sleeve Seals for Communications Pathways and Cabling" for sleeves and sleeve seals for communications.

F. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

G. Complete pathway installation before starting conductor installation.

H. Arrange stub-ups so curved portions of bends are not visible above finished slab.

I. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.

J. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

K. Support conduit within 12 inches of enclosures to which attached.

L. Pathways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot intervals.

2. Arrange pathways to cross building expansion joints at right angles with expansion fittings. Comply with requirements for expansion joints specified in this article.
3. Arrange pathways to keep a minimum of [**1 inch**] [**2 inches**] <**Insert dimension**> of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from nonmetallic conduit and fittings to [**RNC, Type EPC-40-PVC,**] [**GRC**] [**or**] [**IMC**] and fittings before rising above floor.

M. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for pathways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.

O. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

P. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

Q. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.

R. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.

S. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

T. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.

U. Surface Pathways:

1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.

2. Install surface pathway with a minimum 2-inch radius control at bend points.
3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

V. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:

1. 3/4-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet.
2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

W. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway-sealing fittings according to NFPA 70.

X. Install devices to seal pathway interiors at accessible locations. Locate seals, so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service pathway enters a building or structure.
3. Where otherwise required by NFPA 70.

Y. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

Z. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC[**and EMT**] that is located where environmental temperature change may exceed 100 deg F, and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

a. Outdoor Locations Not Exposed to Direct Sunlight: [**125 deg F**] <**Insert temperature**> temperature change.
b. Outdoor Locations Exposed to Direct Sunlight: [**155 deg F**] <**Insert temperature**> temperature change.
c. Indoor Spaces Connected with Outdoors without Physical Separation: [**125 deg F**] <**Insert temperature**> temperature change.
d. Attics: [**135 deg F**] <**Insert temperature**> temperature change.
e. <**Insert location and corresponding temperature change**>.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

AA. Hooks:

1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
3. Hook spacing shall allow no more than 6 inches of slack. The lowest point of the cables shall be no less than 6 inches adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
4. Space hooks no more than 5 feet o.c.
5. Provide a hook at each change in direction.

BB. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to [**center**] [**top**] [**bottom**] of box unless otherwise indicated.

CC. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

DD. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.

EE. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

FF. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

GG. Set metal floor boxes level and flush with finished floor surface.

HH. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 31 20 00 "Earth Moving" for pipe of less than 6 inches in nominal diameter.
2. Install backfill as specified in Section 31 20 00 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 31 20 00 "Earth Moving."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete around conduit for a minimum of 12 inches on each side of the coupling.
    b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

6. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits, but a minimum of 6 inches below grade. Align planks along centerline of conduit.
7. Underground Warning Tape: Comply with requirements in Section 27 05 53 "Identification for Communications Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install handholes with bottom below frost line, <**Insert depth of frost line below grade at Project site**> below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

F. Field cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 CABLE TRAY INSTALLATION

A. Install cable trays according to [**NEMA FG 1**] [**NEMA VE 2**].

B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.

D. Remove burrs and sharp edges from cable trays.

E. Join aluminum cable tray with splice plates; use four square neck-carriage bolts and locknuts.

F. Fasten cable tray supports to building structure[**and install seismic restraints**].

G. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb. Comply with requirements in Section 27 05 29 "Hangers and Supports for Communications Systems."[**Comply with seismic-restraint details**

according to Section 27 05 48.16 "Seismic Controls for Communications Systems."]

H. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.

J. Support bus assembly to prevent twisting from eccentric loading.

K. [Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.]

L. Locate and install supports according to [**NEMA FG 1**] [**NEMA VE 2**]. Do not install more than one cable tray splice between supports.

M. Support wire-basket cable trays with [center support hangers] [trapeze hangers] [wall brackets].

N. Support [center support hangers] [trapeze hangers] for wire-basket trays with [**1/4-inch-**] [**3/8-inch-**] diameter rods.

O. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

P. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in [**NEMA FG 1**] [**NEMA VE 2**]. Space connectors and set gaps according to applicable standard.

Q. Make changes in direction and elevation using manufacturer's recommended fittings.

R. Make cable tray connections using manufacturer's recommended fittings.

S. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

T. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

U. Install cable trays with enough workspace to permit access for installing cables.

V. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.

W. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.

X. Clamp covers on cable trays installed outdoors with heavy-duty clamps.

Y. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.6 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 27 05 26 "Grounding and Bonding for Communications Systems."

B. Cable trays shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."

D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

F. Conduits shall not be grounded to any cable trays, but instead to a dedicated grounding conductor.

3.7 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

C. Fasten cables on vertical runs to cable trays every 18 inches.

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.

E. Tie MI cables down every 36 inches where required to provide a 2-hour fire rating and every 72 inches elsewhere.

F. In existing construction, remove inactive or dead cables from cable trays.

3.8 CONNECTIONS

A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

B. Connect pathways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections[with the assistance of a factory-authorized service representative]:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
7. Check for improperly sized or installed bonding jumpers.
8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.10 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor, so no voids remain. Tool exposed surfaces smooth; protect material while curing.
b. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 07 92 00 "Joint Sealants."

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide [**1/4-inch**] <**Insert dimension**> annular clear space between sleeve and pathway or cable, unless sleeve seal system is to be installed[**or seismic criteria require different clearance**].
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors [**2 inches**] <**Insert dimension**> above finished floor level. Install sleeves during erection of floors.

C. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for wall assemblies.

D. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

E. Aboveground, Exterior-Wall Penetrations: Seal penetrations using [**steel**] [**cast-iron**] pipe sleeves and mechanical sleeve seal systems. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

F. Underground, Exterior-Wall and Floor Penetrations:

1. Install [**steel**] [**cast-iron**] pipe sleeves with integral waterstops. Size sleeves to allow for 1-inch annular clear space between pathway or cable

and sleeve for installing sleeve seal system. Install sleeve during construction of floor or wall.

2. Install steel pipe sleeves. Size sleeves to allow for 1-inch annular clear space between pathway or cable and sleeve for installing sleeve seal system. Grout sleeve into wall or floor opening.

3.11 INSTALLATION OF RECTANGULAR SLEEVES AND SLEEVE SEALS

A. Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.

B. Install conduits and cable with no crossings within the sleeve.

C. Fill opening around conduits and cables with expanding foam without leaving voids.

D. Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.

3.12 INSTALLATION OF SLEEVE SEAL SYSTEMS

A. Install sleeve seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.13 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.14 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

B. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION

SECTION 27 11 00 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Backboards.
2. Power Strips
3. Equipment Racks and Cabinets.
4. Equipment Rack and Cabinet Accessories.
5. Grounding
6. Labeling

B. Related Requirements:

1. Division 27 Section "Pathways for Communications Systems" for cable trays and accessories.
2. Division 27 Section “Grounding and Bonding for Communications Systems” for grounding and bonding of equipment room fittings.
3. Division 27 Section "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
4. Division 27 Section "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.
5. Division 28 Section "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.

B. BICSI: Building Industry Consulting Service International.

C. LAN: Local area network.

D. RCDD: Registered Communications Distribution Designer.

E. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.

F. TGB: Telecommunications grounding bus bar.

G. TMGB: Telecommunications main grounding bus bar.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of the TMGB and TGB and its mounting detail showing standoff insulators and wall mounting brackets.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

B. Seismic Qualification Data: Certificates, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Low Voltage Contractor must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Installer 2, Copper or Fiber, who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

B. UL listed.

C. RoHS compliant.

D. Compliant with requirements of the Payment Card Industry Data Security Standard.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels specified in Division 06 "Rough Carpentry."

1. Mount the plywood 0’-8” above finished floor.

B. Backboard Paint: Light-colored fire-retardant paint.

1. Comply with requirements in Division 09 Section “Interior Painting” for painting backboards. For fire-retardant plywood, do not paint over manufacturer’s fire-retardant stamp(s).

2.3 19-INCH EQUIPMENT RACKS

A. Description: Two-post racks with threaded rails designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch equipment mounting with an opening of 17.72-inches between rails.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. APC
2. B-line; Eaton, Electrical Sector.
3. Chatsworth Product, Inc. (CPI)
4. CommScope, Inc.
5. Hoffman, A Pentair Company
6. Great Lakes Data Racks & Cabinets
7. Middle Atlantic Products; Legrand North America, LLC.
8. Panduit

C. General Requirements:

1. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Material: Extruded steel.
3. Finish: Manufacturer's standard, baked-polyester powder coat.
4. Color: Black.

D. Floor-Mounted Racks:

1. Overall Height: 84 inches.
2. Overall Depth: 23 inches.
3. Upright Depth: 3 inches
4. Two-Post Load Rating: 400 lb.
5. Number of Rack Units per Rack: 45.

   a. Numbering: Every five rack units, on interior of rack.

6. Threads: Universal square.
7. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
8. Base shall have a minimum of four mounting holes for permanent attachment to floor.
9. Top shall have provisions for attaching to cable tray or ceiling.
10. Self-leveling.

E. Cable Management:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

2.4 GROUNDING

A. Comply with requirements in Section 27 05 26 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Rack and Cabinet TGBs: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-606-B. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted TGB: Terminal block, with stainless-steel or copper-plated hardware for attachment to cabinet.
2. Rack-Mounted Horizontal TGB: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
3. Rack-Mounted Vertical TGB: 72 or 36 inches long, with stainless-steel or copper-plated hardware for attachment to rack.

2.5 LABELING

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI's "Telecommunications Distribution Methods Manual" for layout of communications equipment spaces.

C. Comply with BICSI's "Information Technology Systems Installation Methods Manual" for installation of equipment in communications equipment spaces.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

E. Coordinate layout and installation of communications equipment in tracks and in room. Coordinate service entrance configuration with service provider.

1. Meet jointly with systems providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.

3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize configurations and space requirements of communications equipment.
4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.

F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

G. Backboards:

1. Install from 8 inches to 8 feet, 8 inches above finished floor. If plywood is fire rated, ensure that fire-rating stamp is visible after installation.
2. Paint all sides of backboard with two coats of paint, leaving fire rating stamp visible.
3. Comply with requirements for backboard installation in BICSI's "Information Technology Systems Installation Methods Manual" and TIA-569-D.

3.3 SLEEVE AND SLEEVE SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 27 05 44 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.4 FIRESTOPPING

A. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI's "Information Technology Systems Installation Methods Manual," "Firestopping Practices" Ch.

3.5 GROUNDING

A. Comply with NECA/BICSI 607.

B. Install grounding according to BICSI ITSIMM, "Bonding, Grounding (Earthing) and Electrical Protection" Ch.

C. Locate TGB to minimize length of bonding conductors. Fasten to wall, allowing at least 2 inches of clearance behind TGB. Connect TGB with a minimum No. 4 AWG grounding electrode conductor from TGB to suitable electrical building ground. Connect rack TGB to near TGB or the TMGB.

1. Bond the shield of shielded cable to patch panel, and bond patch panel to TGB or TMGB.

3.6 IDENTIFICATION

A. Coordinate system components, wiring, and cabling complying with TIA-606-B. Comply with requirements in Section 27 05 53 "Identification for Electrical Systems."

B. Comply with requirements in Section 09 91 23 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 3 level of administration, including optional identification requirements of this standard.

D. Labels shall be machine printed. Type shall be 3/16 inch in height.

END OF SECTION

SECTION 27 15 00 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Category cable.
2. Twisted pair cable hardware, including plugs and jacks.
3. Optical fiber cable
4. Optical fiber cable connecting hardware, patch panels, and cross-connects.
5. Coaxial Cable
6. Coaxial cable hardware.
7. Multimode optical fiber and copper hybrid cable for Class 2 circuits.
8. Single-mode optical fiber and copper hybrid cable for Class 2 circuits.
9. Cable management system.
10. Cabling identification products.
11. Grounding.
12. Source quality control requirements for twisted pair cable.

B. Related Requirements

1. Division 27 Section "Pathways for Communications Systems"
2. Division 27 Section "Grounding and Bonding for Communications Systems"
3. Division 27 Section "Communications Backbone Cabling"
4. Division 27 Section "Communications Room Fittings"

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EPD: Environmental Product Declaration.

D. EMI: Electromagnetic interference.

E. FTP: Shielded twisted pair.

F. F/FTP: Overall foil screened cable with foil screened twisted pair.

G. F/UTP: Overall foil screened cable with unscreened twisted pair.

H. HPD: Health Product Declaration.

I. IDC: Insulation displacement connector.

J. LAN: Local area network.

K. Jack: Also commonly called an "outlet," it is the fixed, female connector.

L. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.

M. RCDD: Registered Communications Distribution Designer.

N. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

O. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

P. S/FTP: Overall braid screened cable with foil screened twisted pair.

Q. S/UTP: Overall braid screened cable with unscreened twisted pairs.

R. UTP: Unscreened (unshielded) twisted pair.

1.4 HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
3. Bridged taps and splices shall not be installed in the horizontal cabling.

B. A work area is approximately 100 sq. ft. and includes the components that extend from the equipment outlets to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Nominal OD.
2. Minimum bending radius.
3. Maximum pulling tension.

B. Shop Drawings: Reviewed and stamped by RCDD.

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration Drawings and printouts.
4. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:

a. Telecommunications rooms plans and elevations.
b. Telecommunications pathways.
c. Telecommunications system access points.
d. Telecommunications grounding system.
e. Telecommunications conductor drop locations.
f. Typical telecommunications details.
g. Mechanical, electrical, and plumbing systems.

C. [Twisted pair cable][Fiber optic cable] testing plan.

D. Sustainable Design Submittals:

1. Product Data: For each conductor and cable indicating lead content.

2. Environmental Product Declaration: For each product.

3. Health Product Declaration: For each product.
4. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**RCDD,**] [**Installer,**] installation supervisor, and field inspector.

B. Product Certificates: For each type of product.

C. Source quality-control reports.

D. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For cable, splices, and connectors to include in maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On USB media or compact disk, complete with data files.
3. Device address list.

C. Printout of software application and graphic screens.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Connecting Blocks: [**One**] <**Insert number**> of each type.
2. Faceplates: [**One**] <**Insert number**> of each type.
3. Jacks: [**Ten**] <**Insert number**> of each type.
4. Patch-Panel Units: [**One**] <**Insert number**> of each type.
5. Plugs: [**Ten**] <**Insert number**> of each type.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings[**and Cabling Administration Drawings**][**, Cabling Administration Drawings, and field testing program development**] by a [**RCDD**] [**Technician**].
2. Installation Supervision: Installation shall be under the direct supervision of [**Technician**] [**Level 2 Installer**], who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an [**RCDD**] [**Technician**].

B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of twisted pair cable for open and short circuits.
2. Test optical fiber cable to determine the continuity of the strand end to end. Use [**optical fiber flashlight**] [**or**] [**optical loss test set**] <**Insert test instrument**>.
3. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.
4. Test each coaxial cable [**on the reel**] for continuity.

1.11 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.12 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

2.2 GENERAL CABLE CHARACTERISTICS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:

1. Communications, Plenum Rated: Type CMP complying with UL 1685[or Type CMP in listed plenum communications raceway] [or Type CMP in listed cable routing assembly].

2. Communications, Plenum Rated: Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
3. Communications, Non-plenum: Type CMR complying with UL 1666[**and ICEA S-103-701**].
4. Communications, Non-plenum: Type CMP or Type CMR in listed plenum or riser communications raceway.
5. Communications, Non-plenum: Type CMP or Type CMR in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: [**25**] <**Insert value**> or less.
2. Smoke-Developed Index: [**50**] [**450**] <**Insert value**> or less.

C. RoHS compliant.

2.3 CATEGORY 5e TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 5e cable at frequencies up to 100 MHz.

B. Acceptable Horizontal Structured Cabling System Manufactures:

1. Belden
2. Berk-Tek / Leviton
3. Commscope
4. General Cable / Panduit
5. Superior Essex

C. Standard: Comply with ICEA S-90-661, NEMA WC 63.1, and TIA-568-C.2 for Category 5e cables.

D. Conductors: 100-ohm, 24 AWG solid copper.

1. <Sustainable design requires copper cable have under 300 parts lead per million to minimize lead exposure.>

E. Shielding/Screening: [Unshielded twisted pairs (UTP)] [Shielded twisted pairs (FTP)] [Screened twisted pairs (F/UTP)] [Screened and shielded twisted pairs (F/FTP)].

F. Cable Rating: [**Riser**] [**Plenum**].

G. Jacket: [**White**] [**Gray**] <**Insert color**> thermoplastic.

2.4 CATEGORY 6 TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable,[**with internal spline,**] certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.

B. Acceptable Horizontal Structured Cabling System Manufactures:

1. Belden
2. Berk-Tek / Leviton
3. Commscope
4. General Cable / Panduit
5. Superior Essex

C. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.

D. Conductors: 100-ohm, 23 AWG solid copper.

1. <Sustainable design requires copper cable have under 300 parts lead per million to minimize lead exposure.>

E. Shielding/Screening: [Unshielded twisted pairs (UTP)] [Shielded twisted pairs (FTP)] [Screened twisted pairs (F/UTP)] [Screened and shielded twisted pairs (F/FTP)].

F. Cable Rating: [**Riser**] [**Plenum**].

G. Jacket: [**White**] [**Gray**] [**Blue**] [**Yellow**] <**Insert color**> thermoplastic.

2.5 CATEGORY 6a TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable,[**with internal spline,**] certified to meet transmission characteristics of Category 6a cable at frequencies up to 500MHz.

B. Acceptable Horizontal Structured Cabling System Manufactures:

1. Belden
2. Berk-Tek / Leviton
3. Commscope
4. General Cable / Panduit
5. Superior Essex

C. Standard: Comply with TIA-568-C.2 for Category 6a cables.

D. Conductors: 100-ohm, 23 AWG solid copper.

1. <Sustainable design requires copper cable have under 300 parts lead per million to minimize lead exposure.>

E. Shielding/Screening: [Unshielded twisted pairs (UTP)] [Shielded twisted pairs (FTP)] [Screened twisted pairs (F/UTP)] [Screened and shielded twisted pairs (F/FTP)].

F. Cable Rating: [**Riser**] [**Plenum**].

G. Jacket: [**White**] [**Gray**] [**Blue**] [**Yellow**] <**Insert color**> thermoplastic.

2.6 CATEGORY 7 TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable,[**with internal spline,**] certified to meet transmission characteristics of Category 7 cable at frequencies up to 600MHz.

B. Acceptable Horizontal Structured Cabling System Manufactures:

1. Belden
2. Berk-Tek / Leviton
3. Commscope
4. General Cable / Panduit
5. Superior Essex

C. Standard: Comply with ISO 11801, Category F.

D. Conductors: 100-ohm, 22 AWG solid copper.

1. <Sustainable design requires copper cable have under 300 parts lead per million to minimize lead exposure.>

E. Shielding/Screening: Overall [foil shield with foil shielded twisted pairs (F/FTP)] [braided shield with foil shielded twisted pairs (S/FTP)].

F. Cable Rating: [**Riser**] [**Plenum**].

G. Jacket: [**White**] [**Gray**] [**Blue**] [**Yellow**] <**Insert color**> thermoplastic.

2.7 TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

B. Acceptable Horizontal Structured Cabling System Manufactures:

1. Belden
2. Berk-Tek / Leviton
3. Commscope
4. General Cable / Panduit
5. Superior Essex

C. General Requirements for Twisted Pair Cable Hardware:

1. Comply with the performance requirements of [**Category 5e**] [**Category 6**] [**Category 6a**] [**Category 7**].
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
3. Cables shall be terminated with connecting hardware of same category or higher.

D. Source Limitations: [Obtain twisted pair cable hardware from single source from single manufacturer.] [Obtain twisted pair cable hardware from same manufacturer as twisted pair cable, from single source.]

E. Connecting Blocks:

1. 110-style IDC for Category 5e.
2. 66-style IDC for Category 5e.
3. 110-style IDC for Category 6.
4. 110-style IDC for Category 6a.
5. Provide blocks for the number of cables terminated on the block, plus [**25**] <**Insert number**> percent spare, integral with connector bodies, including plugs and jacks where indicated.

F. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: [**One**] <**Insert number**> for each conductor in assigned cables.

G. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

1. Features:

a. Universal T568A and T568B wiring labels.
b. Labeling areas adjacent to conductors.
c. Replaceable connectors.
d. 24 or 48 ports.

2. Construction: 16-gauge steel and mountable on 19-inch equipment racks.
3. Number of Jacks per Field: One for each four-pair [cable indicated] [conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria].

H. Patch Cords: Factory-made, four-pair cables in [**36-inch**] [**48-inch**] <**Insert length**>lengths; terminated with an eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.

2. Patch cords shall have color-coded boots for circuit identification.

I. Plugs and Plug Assemblies:

1. Male; eight position (8P8C); color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Standard: Comply with TIA-568-C.2.
3. Marked to indicate transmission performance.

J. Jacks and Jack Assemblies:

1. Female; eight position (8P8C); modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Designed to snap-in to a patch panel or faceplate.
3. Standard: Comply with TIA-568-C.2.
4. Marked to indicate transmission performance.

K. Faceplate:

1. [**Two**][**Four**] [**Six**] port, vertical single gang faceplates designed to mount to single gang wall boxes.
2. [**Eight**] [**Ten**] [**Twelve**] port, vertical double gang faceplates designed to mount to double gang wall boxes.
3. Plastic Faceplate: High-impact plastic. Coordinate color with Section 26 27 26 "Wiring Devices."
4. Metal Faceplate: [**Stainless steel**] [**Brass**] <**Insert description**>, complying with requirements in Section 26 27 26 "Wiring Devices."
5. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.

a. Flush mounting jacks, positioning the cord at a 45-degree angle.

L. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.8 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

2.9 62.5/125-MICROMETER, MULTIMODE, OPTICAL FIBER CABLE (OM1)

A. Description: Multimode, 62.5/125-micrometer, [**1**] [**2**] [**4**] <**Insert number**>-fiber, [**nonconductive**] [**conductive**], tight buffer, optical fiber cable.

B. Acceptable Horizontal Cabling System Manufactures:

1. Belden
2. Berk-Tek / Leviton
3. Commscope
4. Corning
5. General Cable / Panduit
6. Superior Essex

C. Standards:

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with TIA-492AAAA for detailed specifications.

D. Conductive cable shall be [**steel**] [**aluminum**] armored type.

E. Maximum Attenuation: [**3.50**] <**Insert number**> dB/km at 850 nm; [**1.5**] <**Insert number**> dB/km at 1300 nm.

F. Minimum Overfilled Modal Bandwidth-length Product: 200 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

G. Jacket:

1. Jacket Color: [**Orange**] <**Insert color**>.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

H. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
2. Plenum Rated, Nonconductive: Type OFNP in listed plenum communications raceway.
3. Plenum Rated, Nonconductive: Type OFNP or Type OFNR in metallic conduit.
4. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262; Type OFNP in listed plenum communications raceway; or Type OFNP or Type OFNR in metallic conduit.
5. Plenum Rated, Conductive: Type OFCP complying with NFPA 262.
6. Plenum Rated, Conductive: Type OFCP or Type OFNP in listed plenum communications raceway.

7. Plenum Rated, Conductive: Type OFCP, Type OFNP, Type OFCR, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2.10 50/125 MICROMETER, MULTIMODE, OPTICAL FIBER CABLE (OM2)

A. Description: Multimode, 50/125-micrometer, [**1**] [**2**] [**4**] <**Insert number**>-fiber, [**nonconductive**] [**conductive**], tight buffer, optical fiber cable.

B. Acceptable Horizontal Cabling System Manufactures:

1. Belden
2. Berk-Tek / Leviton
3. Commscope
4. Corning
5. General Cable / Panduit
6. Superior Essex

C. Standards:

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with TIA-492AAAB for detailed specifications.

D. Conductive cable shall be [**steel**] [**aluminum**] armored type.

E. Maximum Attenuation: [**3.50**] <**Insert number**> dB/km at 850 nm; [**1.5**] <**Insert number**> dB/km at 1300 nm.

F. Minimum Overfilled Modal Bandwidth-length Product: 500 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

G. Jacket:

1. Jacket Color: [**Orange**] <**Insert color**>.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

H. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
2. Plenum Rated, Nonconductive: Type OFNP in listed plenum communications raceway.
3. Plenum Rated, Nonconductive: Type OFNP or Type OFNR in metallic conduit.

4. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262; Type OFNP in listed plenum communications raceway; or Type OFNP or Type OFNR in metallic conduit.
5. Plenum Rated, Conductive: Type OFCP[**or Type OFNP**], complying with NFPA 262.
6. Plenum Rated, Conductive: Type OFCP or Type OFNP in listed plenum communications raceway.
7. Plenum Rated, Conductive: Type OFC, Type OFN, Type OFCG, Type OFNG, Type OFCP, Type OFNP, Type OFCR, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2.11 850 NANOMETER LASER-OPTIMIZED, 50/125 MICROMETER, MULTIMODE OPTICAL FIBER CABLE (OM3)

A. Description: Multimode, 50/125-micrometer, [**1**] [**2**] [**4**] <**Insert number**>-fiber, [**nonconductive**] [**conductive**], tight buffer, optical fiber cable.

B. Acceptable Horizontal Cabling System Manufactures:

1. Belden
2. Berk-Tek / Leviton
3. Commscope
4. Corning
5. General Cable / Panduit
6. Superior Essex

C. Standards:

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with TIA-492AAAC for detailed specifications.

D. Conductive cable shall be [**steel**] [**aluminum**] armored type.

E. Maximum Attenuation: [**3.50**] <**Insert number**> dB/km at 850 nm; [**1.5**] <**Insert number**> dB/km at 1300 nm.

F. Minimum Overfilled Modal Bandwidth-length Product: 1500 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

G. Minimum Effective Modal Bandwidth-length Product: 2000 MHz-km at 850 nm.

H. Jacket:

1. Jacket Color: [**Aqua**] <**Insert color**>.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

I. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
2. Plenum Rated, Nonconductive: Type OFNP in listed plenum communications raceway.
3. Plenum Rated, Nonconductive: Type OFNP or Type OFNR in metallic conduit.
4. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262; Type OFNP in listed plenum communications raceway; or Type OFNP or Type OFNR in metallic conduit.
5. Plenum Rated, Conductive: Type OFCP[**or Type OFNP**], complying with NFPA 262.
6. Plenum Rated, Conductive: Type OFCP or Type OFNP in listed plenum communications raceway.
7. Plenum Rated, Conductive: Type OFNG, Type OFCP, Type OFNP, Type OFCR, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2.12 850 NANOMETER LASER-OPTIMIZED, 50/125 MICROMETER, MULTIMODE OPTICAL FIBER CABLE (OM4)

A. Description: Multimode, 50/125-micrometer, [**1**] [**2**] [**4**] <**Insert number**>-fiber, [**nonconductive**] [**conductive,**]tight buffer, optical fiber cable.

B. Acceptable Horizontal Cabling System Manufactures:

1. Belden
2. Berk-Tek / Leviton
3. Commscope
4. Corning
5. General Cable / Panduit
6. Superior Essex

C. Standards:

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with TIA-492AAAD for detailed specifications.

D. Conductive cable shall be [**steel**] [**aluminum**] armored type.

E. Maximum Attenuation: [**3.50**] <**Insert number**> dB/km at 850 nm; [**1.5**] <**Insert number**> dB/km at 1300 nm.

F. Minimum Overfilled Modal Bandwidth-length Product: 3500 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

G. Minimum Effective Modal Bandwidth-length Product: 4700 MHz-km at 850 nm.

H. Jacket:

1. Jacket Color: [**Aqua**] <**Insert color**>.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

I. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
2. Plenum Rated, Nonconductive: Type OFNP in listed plenum communications raceway.
3. Plenum Rated, Nonconductive: Type OFNP or Type OFNR in metallic conduit.
4. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262; Type OFNP in listed plenum communications raceway; or Type OFN, Type OFNG, Type OFNP, or Type OFNR in metallic conduit.
5. Plenum Rated, Conductive: Type OFCP, complying with NFPA 262.
6. Plenum Rated, Conductive: Type OFCP or Type OFNP in listed plenum communications raceway.
7. Plenum Rated, Conductive: Type OFCP, Type OFNP, Type OFCR, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2.13 9/125 MICROMETER SINGLE-MODE, INDOOR-OUTDOOR OPTICAL FIBER CABLE (OS1)

A. Description: Single mode, 9/125-micrometer, [**1**] [**2**] <**Insert number**> fibers, tight buffered, [**nonconductive**] [**conductive**] optical fiber cable.

B. Acceptable Horizontal Cabling System Manufactures:

1. Belden
2. Berk-Tek / Leviton
3. Commscope
4. Corning
5. General Cable / Panduit
6. Superior Essex

C. Conductive cable shall be [**steel**] [**aluminum**] armored type.

D. Maximum Attenuation: [**0.5**] <**Insert number**> dB/km at 1310 nm; [**0.5**] <**Insert number**> dB/km at 1550 nm.

E. Jacket:

1. Jacket Color: [**Yellow**] <**Insert color**>.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.

3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

F. Standards:

1. Comply with TIA-492CAAA for detailed specifications.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with ICEA S-104-696 for mechanical properties.

G. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
2. Plenum Rated, Nonconductive: Type OFNP in listed plenum communications raceway.
3. Plenum Rated, Nonconductive: Type OFNP or Type OFNR in metallic conduit.
4. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262; Type OFNP in listed plenum communications raceway; or Type OFN, Type OFNG, Type OFNP, or Type OFNR in metallic conduit.
5. Plenum Rated, Conductive: Type OFCP, complying with NFPA 262.
6. Plenum Rated, Conductive: Type OFCP or Type OFNP in listed plenum communications raceway.
7. Plenum Rated, Conductive: Type OFCP, Type OFNP, Type OFCR, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2.14 9/125 MICROMETER, SINGLE-MODE, INDOOR-OUTDOOR OPTICAL FIBER CABLE (OS2)

A. Description: Single mode, 9/125-micrometer, [**1**] [**2**] <**Insert number**> fibers, tight buffered, [**nonconductive**] [**conductive**] optical fiber cable.

B. Acceptable Horizontal Cabling System Manufactures:

1. Belden
2. Berk-Tek / Leviton
3. Commscope
4. Corning
5. General Cable / Panduit
6. Superior Essex

C. Conductive cable shall be [**steel**] [**aluminum**] armored type.

D. Maximum Attenuation: [**0.5**] <**Insert number**> dB/km at 1310 nm; [**0.5**] <**Insert number**> dB/km at 1550 nm.

E. Jacket:

1. Jacket Color: [**Yellow**] <**Insert color**>.

2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

F. Standards:

1. Comply with TIA-492CAAB for detailed specifications.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with ICEA S-104-696 for mechanical properties.

G. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
2. Plenum Rated, Nonconductive: Type OFNP in listed plenum communications raceway.
3. Plenum Rated, Nonconductive: Type OFNP or Type OFNR in metallic conduit.
4. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262; Type OFNP in listed plenum communications raceway; or Type OFN, Type OFNG, Type OFNP, or Type OFNR in metallic conduit.
5. Plenum Rated, Conductive: Type OFCP, complying with NFPA 262.
6. Plenum Rated, Conductive: Type OFCP or Type OFNP in listed plenum communications raceway.
7. Plenum Rated, Conductive: Type OFCP, Type OFNP, Type OFCR, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2.15 OPTICAL FIBER CABLE HARDWARE

A. Acceptable Horizontal Cabling System Manufactures:

1. Belden
2. Berk-Tek / Leviton
3. Commscope
4. Corning
5. General Cable / Panduit
6. Superior Essex

B. Standards:

1. Comply with Fiber Optic Connector Intermateability Standard (FOCIS) specifications of the TIA-604 series.
2. Comply with TIA-568-C.3.

C. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: [**One**] <**Insert number**> for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

D. Patch Cords: Factory-made, single-fiber cables in 36-inch lengths.

E. Connector Type: [Type SC complying with TIA-604-3-B,] [Type ST complying with TIA-604-2-B,] [Type LC complying with TIA-604-10-B,] [Type MT-RJ complying with TIA-604-12,] [Type MPO complying with TIA-604-5-D,] <Insert type> connectors.

F. Plugs and Plug Assemblies:

1. Male; color-coded modular telecommunications connector designed for termination of a single optical fiber cable.
2. Insertion loss not more than [**0.25**] [**0.75**] <**Insert number**> dB.
3. Marked to indicate transmission performance.

G. Jacks and Jack Assemblies:

1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of a single optical fiber cable.
2. Insertion loss not more than [**0.25**] [**0.75**] <**Insert number**> dB.
3. Marked to indicate transmission performance.
4. Designed to snap-in to a patch panel or faceplate.

H. Faceplate:

1. [**Two**][**Four**] [**Six**] -port, vertical single-gang faceplates designed to mount to single-gang wall boxes.
2. [**Eight**] [**Ten**] [**Twelve**] -port, vertical double-gang faceplates designed to mount to double-gang wall boxes.
3. Plastic Faceplate: High-impact plastic. Coordinate color with Section 26 27 26 "Wiring Devices."
4. Metal Faceplate: [**Stainless steel**] [**Brass**] <**Insert description**>, complying with requirements in Section 26 27 26 "Wiring Devices."
5. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.

a. Flush mounting jacks, positioning the cord at a 45-degree angle.

2.16 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard, and the requirements of TIA-568-C.4.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

2.17 GENERAL CABLE CHARACTERISTICS

A. Communications Cable: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:

1. Communications, Plenum Rated: Type CMP complying with UL 1685[or Type CMP in listed plenum communications raceway] [or Type CMP in listed cable routing assembly].
2. Communications, Plenum Rated: Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

B. CATV Cable: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:

1. CATV Plenum Rated: Type CATVP [**installed in riser raceways or cable routing assemblies**], complying with NFPA 262.
2. CATV Cable: Type CATV[, or CATVP or CATVR] [installed in general purpose, riser, or plenum communications raceways or cable routing assemblies] in fireproof riser shafts with firestops at each penetration.

2.18 COMMUNICATIONS COAXIAL CABLE

A. Description: Coaxial cable with a 75-ohm characteristic impedance designed for broadband data transmission.

B. Acceptable Horizontal Cabling System Manufactures:

1. Belden
2. Berk-Tek / Leviton
3. Commscope
4. General Cable / Panduit
5. Superior Essex

C. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 13, and with NFPA 70, "Class 1, Class 2, and Class 3 Remote-Control, Signaling, and Power-Limited Circuits" and "Communications Circuits" articles. Types are as follows:

1. Series-6/U: UL Type [**CMP**] [**and**] [**CL2P**].

a. No. [**16**] [**18**] <**Insert size**> AWG, solid, copper-covered steel conductor.
b. Plenum rated.
c. Gas-injected, foam-PE insulation.

d. Shielded with 100 percent aluminum tape and [**40**] [**60**] percent aluminum braid.
e. Double shielded with 100 percent aluminum foil shield, 60 percent aluminum braided inner shield, and 40 percent aluminum braided outer shield.
f. Jacketed with [**black**] [**white**] PVC or PE.
g. Suitable for indoor installations.

2. Series-11/U: UL Type [**CMP**] [**and**] [**CL2P**].

a. No. [**14**] <**Insert size**> AWG, solid, copper-covered steel conductor.
b. Plenum rated. Suitable for outdoor installations in ambient temperatures ranging from minus 40 to plus 85 deg F.
c. Gas-injected, foam-PE insulation.
d. Shielded with 100 percent aluminum tape and [**40**] [**60**] percent aluminum braid.
e. Double shielded with 100 percent aluminum foil shield, 60 percent aluminum braided inner shield, and 40 percent aluminum braided outer shield.
f. Jacketed with sunlight-resistant, [**black**] [**white**] PVC or PE.

3. Series-59/U: UL Type [**CMP**] [**and**] [**CL2P**].

a. No. [**20**] <**Insert size**> AWG, solid copper conductor.
b. Plenum rated.
c. Gas-injected, foam-PE insulation.
d. Single shielded with 100 percent aluminum shield and 40 percent aluminum braid.
e. PVC jacket.

2.19 CATV COAXIAL CABLE

A. Description: Coaxial cable with a 75-ohm characteristic impedance designed for CATV transmission.

B. Acceptable Horizontal Cabling System Manufactures:

1. Alpha Wire.
2. Belden Inc.
3. Carol Brand
4. Commscope

C. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70, "Community Antenna Television and Radio Distribution Systems" Article. Types are as follows:

1. Series-6/U: UL Type CATVP.

a. No. 18 AWG, solid, copper-covered steel conductor.
b. Plenum rated.

c. Gas-injected, foam-PE insulation.
d. Shielded with 100 percent aluminum tape and [**40**] [**60**] percent aluminum braid.
e. Double shielded with 100 percent aluminum foil shield, 60 percent aluminum braided inner shield, and 40 percent aluminum braided outer shield.
f. Jacketed with [**black**] [**white**] PVC or PE.
g. Suitable for indoor installations.

2.20 COAXIAL CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate coaxial cable with a 75-ohm characteristic impedance.

B. Acceptable Horizontal Cabling System Manufactures:

1. Belden
2. Blonder Tongue
3. Leviton
4. Commscope
5. Panduit
6. Siemon Co. (The)

C. Coaxial-Cable Connectors: Type BNC, 75 ohms.

D. Jacks and Jack Assemblies: Modular, color-coded, with female Type BNC connectors.

E. Patch Cords: Factory-made cables in [**36-inch**] [**48-inch**] <**Insert length**>lengths; terminated with a male Type BNC connector at each end.

F. Faceplates:

1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 26 27 26 "Wiring Devices."
2. Metal Faceplate: [**Stainless steel**] [**Brass**] <**Insert description**>, complying with requirements in Section 26 27 26 "Wiring Devices."
3. For use with snap-in jacks accommodating any combination of twisted pair, optical-fiber, and coaxial work area cords.

   a. Flush-mounted jacks, positioning the cord at a 90-degree angle from faceplate surface.

4. Legend:

   a. Factory labeled by silk-screening or engraving [**for**] [**stainless steel**] [**brass**] <**Insert description**> [**faceplates**].
   b. Machine printed, in the field, using adhesive-tape label.
   c. Snap-in, clear-label covers and machine-printed paper inserts.

2.21 PERFORMANCE REQUIREMENTS

A. General Performance:

1. Cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.
2. Comply with UL 13.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

D. RoHS compliant.

2.22 MULTIMODE OPTICAL FIBER AND COPPER HYBRID CABLE

A. "Description" Paragraph below includes common characteristics of common hybrid cables. Verify cable construction with manufacturer.

B. Description: [**One**] [**Two**] [**Four**] <**Insert number**> 62.5/125-micrometer multimode optical fibers and [**two**] <**Insert number**> copper conductors sharing a common jacket.

C. Acceptable Horizontal Cabling System Manufactures:

1. Belden
2. Berk-Tek / Leviton
3. Commscope
4. Corning

D. Copper Conductors:

1. Comply with ASTM B3 for stranded conductors.
2. Size: [12 AWG] [14 AWG] [16 AWG] [18 AWG] [20 AWG].
3. Insulation: [THWN] [THHN] <Insert insulation type>.

E. Optical Fiber:

1. Type: [62.5/125-micrometer, multimode, optical fiber cable (OM1)] [50/125-micrometer, multimode, optical fiber cable (OM2)] [850-nanometer, laser-optimized, 50/125-micrometer, multimode optical fiber cable (OM3)] [850-nanometer, laser-optimized, 50/125-micrometer multimode optical fiber cable (OM4)].
2. Maximum Attenuation: [**0.5**] <**Insert number**> dB/km at 1310 nm; [**0.5**] <**Insert number**> dB/km at 1550 nm.

F. Jacket:

1. Jacket Color: [Black] [Yellow] [Orange] <Insert color>.

2. Imprinted with fiber count, fiber type, copper count, copper size, and aggregate length at regular intervals not to exceed 40 inches.

G. Shield: [Aluminum foil] [Aluminum braid] <Insert type>.

H. Armor: [**Steel**] [**Aluminum**].

I. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with NFPA 70, Article 725 for the following types:

1. Plenum Rated: Type CL3P and CL2P, complying with NFPA 262.
2. Riser Rated: Type CL3R and CL2R, complying with UL 1666.
3. Riser Rated: Type CMR, complying with UL 444.
4. Tray Cable: Type PLTC.

2.23 SINGLE-MODE OPTICAL FIBER AND COPPER HYBRID CABLE

A. "Description" Paragraph below includes common characteristics of common hybrid cables. Verify cable construction with manufacturer.

B. Description: [**One**] [**Two**] [**Four**] <**Insert number**> single-mode optical fibers and [**two**] <**Insert number**> copper conductors sharing a common jacket.

C. Acceptable Horizontal Cabling System Manufactures:

1. Belden
2. Berk-Tek / Leviton
3. Commscope
4. Corning

D. Copper Conductors:

1. Comply with ASTM B3 for stranded conductors.
2. Size: [12 AWG] [14 AWG] [16 AWG] [18 AWG] [20 AWG].
3. Insulation: [THWN] [THHN] <Insert insulation type>.

E. Optical Fiber:

1. Type: [9/125-micrometer, single-mode, indoor-outdoor optical fiber cable (OS1)] [9/125-micrometer, single-mode, indoor-outdoor optical fiber cable (OS2)] [9/125-micrometer, single-mode, ISP optical fiber cable (OS1)] [9/125-micrometer, single-mode, ISP optical fiber cable (OS2)] [9/125-micrometer, single-mode, OSP optical fiber cable (OS1)] [9/125-micrometer, single-mode, OSP optical fiber cable (OS2)].
2. Maximum Attenuation: [**0.5**] <**Insert number**> dB/km at 1310 nm; [**0.5**] <**Insert number**> dB/km at 1550 nm.

F. Jacket:

1. Jacket Color: [Black] [Yellow] [Orange] <Insert color>.
2. Imprinted with fiber count, fiber type, copper count, copper size, and aggregate length at regular intervals not to exceed 40 inches.

G. Shield: [Aluminum foil] [Aluminum braid] <Insert type>.

H. Armor: [**Steel**] [**Aluminum**].

I. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with NFPA 70, Article 725 for the following types:

1. Plenum Rated: Type CL3P and CL2P, complying with NFPA 262.
2. Riser Rated: Type CL3R and CL2R, complying with UL 1666.
3. Riser Rated: Type CMR, complying with UL 444.
4. Tray Cable: Type PLTC.

2.24 CABLE MANAGEMENT SYSTEM

A. Description: Computer-based cable management system, with integrated database[**and graphic**] capabilities.

B. Document physical characteristics by recording the network, TIA details, and connections between equipment and cable.

C. Information shall be presented in database view[**, schematic plans, or technical drawings**].

1. [**Microsoft Visio Professional**] [**or**] [**AutoCAD**] drawing software shall be used as drawing and schematic plans software.

D. System shall interface with the following testing and recording devices:

1. Direct upload tests from circuit testing instrument into the personal computer.
2. Direct download circuit labeling into labeling printer.

2.25 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.26 GROUNDING

A. Comply with requirements in Section 27 05 26 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Comply with TIA-607-B.

2.27 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA-568-C.1.

C. Factory test twisted pair cables according to TIA-568-C.2.

D. Factory test multimode optical fiber cables according to TIA-526-14-B and TIA-568-C.3.

E. Factory test pre-terminated optical fiber cable assemblies according to TIA-526-14-B and TIA-568-C.3.

F. Cable will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate horizontal cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters[**and except in accessible ceiling spaces, attics, and gypsum board partitions where unenclosed wiring method may be used**]. Conceal raceway and cables, except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Section 27 05 28 "Pathways for Communications Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

3.3 Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

3.4 INSTALLATION OF PATHWAYS

A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 27 11 00 "Communications Equipment Room Fittings."

B. Comply with Section 27 05 28 "Pathways for Communications Systems."

C. Comply with Section 27 05 29 "Hangers and Supports for Communications Systems."

D. Comply with Section 27 05 36 "Cable Trays for Communications Systems."

E. Drawings indicate general arrangement of pathways and fittings.

3.5 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:

1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
6. MUTOA shall not be used as a cross-connect point.
7. Consolidation points may be used only for making a direct connection to equipment outlets:

   a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
   b. Locate consolidation points for twisted-pair cables at least 49 feet from communications equipment room.

8. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
9. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.

10. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
11. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
12. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
13. In the communications equipment room, install a 10-foot-long service loop on each end of cable.
14. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than [**60 inches**] <**Insert dimension**> apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable [**6 feet**] <**Insert size**> long not less than [**12 inches**] <**Insert size**> in diameter below each feed point.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.6 INSTALLATION OF OPTICAL FIBER CABLES

A. Comply with NECA 1, NECA 301 and NECA/BICSI 568.

B. General Requirements for Optical Fiber Cabling Installation:

1. Comply with TIA-568-C.1 and TIA-568-C.3.
2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
3. Terminate all cables; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
9. In the communications equipment room, provide a 10-foot-long service loop on each end of cable.

10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable [**6 feet**] <**Insert size**> long not less than [**12 inches**] <**Insert size**> in diameter below each feed point.

E. Group connecting hardware for cables into separate logical fields.

3.7 INSTALLATION OF COAXIAL HORIZONTAL CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:

1. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
2. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and patch panels.
3. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
4. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
8. In the communications equipment room, install a 10-foot-long service loop on each end of cable.

9. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Pulling Cable" Section. Monitor cable pull tensions.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend coaxial cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than [**60 inches**] <**Insert dimension**> apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable [**6 feet**] <**Insert size**> long not less than [**12 inches**] <**Insert size**> in diameter below each feed point.

E. Outdoor Coaxial Cable Installation:

1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:

1. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of 12 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

2. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of 6 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

3. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
b. Electrical Equipment Rating Between 2 and 5 kVA: A minimum of 3 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

4. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
5. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.8 INSTALLATION OF HYBRID CABLES

A. Comply with NECA 1 and NECA 301.

B. General Requirements for Cabling:

1. Comply with TIA-568-C Series of standards.
2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems" and Ch. 6, "Optical Fiber Structured Cabling Systems" for cable terminations.
3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
4. Cables may not be spliced.
5. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
7. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 6, "Cabling Termination Practices." Use lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
10. In the communications equipment room, provide a 10-foot-long service loop on each end of cable.
11. Pulling Cable: Comply with requirements of BICSI ITSIMM Ch. 5, "Copper Structured Cabling Systems," and Ch. 6, "Optical Fiber Structured Cabling Systems" for pulling cable. Monitor cable pull tensions.
12. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable [**6 feet**] <**Insert size**> long not less than [**12 inches**] <**Insert size**> in diameter below each feed point.

E. Group connecting hardware for cables into separate logical fields.

3.9 FIRESTOPPING

A. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with "Firestopping Systems" Article in BISCI's "Telecommunications Distribution Methods Manual."

3.10 GROUNDING

A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."

B. Comply with TIA-607-B and NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.

D. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.11 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 27 05 53 "Identification for Communications Systems."

1. Administration Class: [**Class 1**] [**Class 2**] [**Class 3**] [**Class 4**].
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Paint and label colors for equipment identification shall comply with TIA-606-B for [**Class 2**] [**Class 3**] [**Class 4**] level of administration[**, including optional identification requirements of this standard**].

C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

E. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.

3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.

a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

F. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.12 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections[with the assistance of a factory-authorized service representative].

E. Tests and Inspections:

1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment, and patch cords, and labeling of all components.
3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

4. Optical Fiber Cable[**and Hybrid cable**] Tests:

    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:

        1) Horizontal and Multimode Horizontal Link Measurements: Test at 850 or 1300 nm in one direction according to TIA-526-14-B, Method B, One Reference Jumper.
        2) Attenuation test results for horizontal links shall be less than 2.0 dB. Attenuation test results shall be less than those calculated according to equation in TIA-568-C.1.

5. Coaxial Cable Tests:

    a. Test coaxial horizontal copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination.

F. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

G. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

H. End-to-end cabling will be considered defective if it does not pass tests and inspections.

I. Prepare test and inspection reports.

END OF SECTION

SECTION 27 52 23 - NURSE CALL/CODE BLUE SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 RELATED WORK AND REQUIREMENTS

A. Section 26 05 33 – Raceway and Boxes for Electrical Systems

B. Section 27 05 00 – Common Work Results for Communications

C. Section 27 05 26 – Grounding and Bonding for Communications Systems

D. Section 27 05 28 – Pathways for Communications Systems

E. Section 27 11 00 - Communication Equipment Room Fittings

1.3 DEFINITIONS

A. ADT: Admission Discharge Transfer System

B. AFF: Above Finished Floor

C. AHJ: Authority Having Jurisdiction

D. Approved: Unless otherwise stated, materials, equipment, or submittals approved by the Authority or AHJ

E. Circuit: Wire path from a group of devices or appliances to a control module

F. DL: Dome Light

G. ESM: Event Subscription Manager

H. HL7: Health Level 7 protocol

I. IP: Internet Protocol

J. IPN: IP Network

K. PD: Peripheral Device

L. PN: Peripheral Network

M. PSpkr: Pillow Speaker

N. SC: Staff Console (Master Station)

O. UL or ULI: Underwriters Laboratories, Inc.

P. UL Listed: Materials or equipment Listed and included in the most recent edition of the UL Equipment Directory

1.4 SUMMARY

A. This Section includes audiovisual equipment using voice communications and microprocessor control. All stations in a geographical area are connected to a master station. Master stations are capable of communicating selectively with each other and with connected patient and other stations.

B. This Section includes a centralized code blue annunciation system. All code blue devices shall annunciate both at the associated master station and at a twenty-four hour monitored locations.

C. The work required under this section shall include all labor, materials, equipment and services necessary for, and reasonably incidental to, the furnishing and installation of nurse call systems as shown on the drawings and specified herein.

1.5 RESPONSIBILITY

A. The term Low voltage Contractor as used in this document refers to the company, group, or individual that has contract responsibility for implementing the terms and directives of this specification document and to produce the finished product as described here-in.

B. It is the responsibility of the prospective low voltage contractor to understand the existing site and nurse call system conditions. The prospective low voltage contractor shall survey the existing site thoroughly as to understand the project conditions.

C. It is the responsibility of the low voltage contractor to coordinate delivery of the nurse call equipment and all work with the general contractor and other trades related to scheduling, rough-in, and finishing of the work specified. The Owner will not be liable for any additional costs due to missed dates or poor coordination of the low voltage contractor with the general contractor and other trades.

D. Edit verbiage to incorporate project specific conditions. Demolition and removal of all nurse call devices and cabling shall be responsibility of the General Contractor. In areas adjacent to working (to remain) nurse call and other low voltage communications systems it shall be the responsibility of the General Contractor to maintain the integrity of the working systems which may included contracting with an authorized low voltage contractor to complete the demolition. Repairing any working low voltage communications systems damaged during demolition shall be the responsibility of the General Contractor and shall be completed at no cost to the Owner.

E. The Low Voltage Contractor for this project shall be contracted by the General Contractor/Electrical Contractor.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Equipment List: Component quantities, equipment manufacturer, model number, and description of each component being supplied. If equipment being supplied is not the specified equipment manufacturer's model, alongside the submitted model number and description, list the specification paragraph that corresponds to the equivalent specified model. Failure to provide this information will result in the rejection of submittals.

C. Shop Drawings: Detail the system including the following:

1. Cabling Diagrams: Single-line block diagrams showing cabling interconnection of all components for this specific equipment. Include cable type for each interconnection.
2. Wiring Diagrams: Power, signal, and control wiring.
3. Station Installation Details: For built-in equipment; dimensioned and to scale.
4. Equipment Cabinet Drawings: Dimensioned and to scale.

D. Coordination Drawings: Detail system components that fit, match, and line up with provisions made in equipment specified in other Sections or in separate contracts:

1. Patient head-wall units.
2. Patient consoles.
3. Patient beds with built-in nurse call features.

E. Manufacturer Certificates:

1. Signed by manufacturers certifying that nurse call equipment complies with requirements.
2. Letter from manufacturer stating that the supplying contractor is an Authorized Distributor of the product being supplied dated recently (within one year from submittal date).

3. Copy of the installing technician(s) certificate of completion from the manufacturer's training school for the equipment being proposed.

F. Field Tests Reports and Observations: Include record of final adjustments certified by Installer.

G. Operation and Maintenance Data: For nurse call equipment to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Operating instructions.
2. Troubleshooting guide.
3. Wiring diagrams and terminal identification.
4. Equipment parts list.
5. Product data for types and sizes of wires and cables used.

H. Warranty:

1. Special warranty specified in this Section.
2. Statement of warranty policy from Manufacturer.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Manufacturer Qualifications: A firm experienced in manufacturing equipment similar to that indicated for this Project and that maintains technical support services capable of providing user with training, parts, and emergency maintenance and repair with a 24-hour-maximum response time.

C. Source Limitations: Obtain nurse call equipment components through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled according to UL 1069 as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.8 COORDINATION

A. Coordinate patient control units with items controlled that are not part of nurse call equipment.

1. TV: Channel selection and volume.
2. Lights: Up light and down light at patient location.

B. Coordinate wiring paths and maintenance access at locations listed below. Coordinate trim features and finishes at these locations to present a unified design appearance.

1. Patient head-wall units.
2. Patient consoles.
3. Patient beds with built-in nurse call features.
4. Nurse station.

1.9 WARRANTY

A. The System Supplier shall provide a warranty on the system which shall include all necessary labor and equipment to maintain the system(s) in full operation for a period of one year from the date of acceptance.

B. The equipment (parts) warranty for all core system components including control / switching equipment, power supplies, patient stations, sub-stations, and nurse consoles shall extend to a total of at least five (5) years. Warranty for ancillary devices such as pillow speakers and call cords shall extend to a total of at least two (2) years.

C. Manufacturer shall provide, free of charge, product firmware/software upgrades throughout the warranty period for any product feature enhancements.

D. After the acceptance of the system(s) service shall be available and provided on the following basis:

1. Emergency Service - Provided **24 hours a day**. When a **total or catastrophic failure** of equipment is reported to contractor, within **2 hours of notification**, a service person will be on site. (An example of a catastrophic failure would be a hub failure or a nurse console failure.)
2. Routine Service - Provided **within 4 business hours of notification**. When a minor failure or equipment is reported to contractor, a service person will be on site within 24 hours of notification. (An example of a minor failure includes peripheral equipment such as control stations, entertainment speakers, corridor lights, pull-cord stations, etc. which normally affect only one patient or patient room.)

E. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace batteries that fail in materials or workmanship within specified warranty period. Special warranty, applying to batteries only, applies to materials only, on a prorated basis, for period specified.

1. Warranty Period: Include the following warranty periods, from date of Acceptance:

a. Nickel-Cadmium, Wet-Cell Batteries:

1) Full Warranty: Five years.
2) Pro Rata: 15 years.

1.10 MAINTENANCE

A. The Owner may choose to have the supplying vendor maintain the system(s). The level of service provided during the maintenance contract period would be the same as the warranty period for routine and emergency service. All labor and equipment costs would be covered under this contract. Supplying vendor must state exact billing amounts, billing periods and all costs associated with this maintenance agreement and list any items that would not be covered under the service/maintenance agreement.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:

1. Cornell Communications, Inc.
2. Dukane Corporation; Communications Systems Div.
3. GE Security, Sound and Communicaitons
4. Hill Rom, Inc.
5. Intercall Systems, Inc.
6. Jeron Electronic Systems, Inc.
7. Rauland-Borg Corporation.
8. TekTone Sound & Signal Mfg., Inc.
9. Simplex Grinnell LP.
10. Wescom Products, Inc.

2.2 SYSTEM REQUIREMENTS

A. Coordinate the features of materials and equipment to form an integrated system. Match components and interconnections for optimum performance of specified functions. Where a functional specification is listed or where more than one manufacturer is listed, this contractor shall have the option to use such equipment provided that all aspects of the specifications are met. Where two or more units of the same class of equipment are required, only a single manufacturer to be used, but individual classes of equipment may be the products of different manufacturers. All equipment must be compatible. Additional equipment accessories or incidentals required, whether or not specifically mentioned herein, shall be provided without claim for additional payment, being understood that a complete operational system is required.

B. Expansion Capability: Equipment ratings, housing volume, spare keys, switches, relays, annunciator modules, terminals, and cable conductor quantities shall be adequate to increase the number of stations in the future by 25 percent above those indicated without adding internal or external components or main trunk cable conductors.

C. Existing System Compatibility: Functionally and electrically compatible with existing system so components and wiring operate as an extension of the existing system and all functional performance of the existing system applies to the final system. Colors, tones, types, and durations of signal manifestation are common between new and existing systems.

D. All Code Blue calls shall be annunciated at the Master Station local to the individual call as well as centrally annunciated at a location monitored 24 hours a day. The 24 hour location shall be the Switchboard and Emergency Department.

E. Resistance to Electrostatic Discharge: System, components, and cabling, and the selection, arrangement, and connection of materials and circuits, shall be protected against damage or diminished performance when subjected to electrostatic discharges of up to 25,000 V in an environment with a relative humidity of 20 percent or less.

F. All relays and similar devices shall have dust covers which protect against fouling by dust or other material which may adversely affect their normal operation.

G. Equipment: Solid state and modular. Like units, assemblies, subassemblies and replaceable parts shall be interchangeable as complete items.

H. Wall-Mounted Component Connection Method: Components connect to system wiring in back boxes with factory-wired plug connectors.

2.3 FUNCTIONAL PERFORMANCE (Audio/ Visual System)

A. The System shall be network-based and incorporate decentralized, distributed intelligence architecture. This intelligent architecture shall be built on an IP (Internet Protocol) network. The System shall allow both data and voice to be distributed over a common network infrastructure, which is consistent with the communication industry. Communication devices on the network will utilize standards-based protocols.

B. Station Selection: Master station is capable of selectively communicating with other stations or groups of stations on its system by operating selector switches.

C. Master Station Privacy: Capable of conversing with individual stations in complete privacy.

D. Hands Free: Called station is capable of conversing hands free.

E. Annunciation: At the master station, a tone announces an incoming call and an annunciator light or liquid-crystal display identifies the calling station and indicates the priority of the call. Memory lamps or lighted displays identify stations selected for outgoing calls.

F. System Reset at Master Station: A normal incoming call is canceled, associated lights and audible tones are extinguished, and the system is reset when the station switch is returned to the normal position after responding to a call.

G. Patient Station Call: Lights the call-placed lamp at patient station, zone, and corridor dome lights. It sounds a tone and lights the call lights at staff/duty stations and actuates annunciation at the master station. When the calling station is selected at the master station, the patient can converse with the master station without moving and without raising or directing the voice. During voice communications, entertainment audio at the calling station is automatically muted.

H. Staff Assistance Station Call: Lights call-placed lamp, and flashes the corridor dome light and zone light(s) at a distinctive interval. Master station tone pulses and annunciator light for that room flashes. When master station acknowledges the call by operating a switch, the tone stops but lights continue to flash until the call is canceled at the point of origin.

I. Pull-Cord Call Station and Emergency-Call Station Call: Lights call-placed lamp and flashes the corridor dome light and zone light(s) at a distinctive interval. Master station tone pulses faster than a Staff Assistance Call and annunciator light for that room flashes. When master station acknowledges the call by operating a switch, the tone stops but lights continue to flash until the call is canceled at the point of origin.

J. Code Blue, Staff, and Duty Station Call: Lights the call-placed lamp at the station, flashes a unique colored corridor dome light and zone light and actuates annunciation at the master station and simultaneously at the 24-hour location. When the called station is selected at the master station, the caller and the master station operator can converse if a two-way audio channel is available at the Code Blue location.

1. Code Blue: Unique sound and light pattern, indicating the highest priority emergency.
2. Staff Station: Unique sound and light pattern, indicating an emergency.
3. Duty Station: Sound and light pattern, indicating a call to the nurse station.

K. Handset Operation: Lifting handset on master station disconnects speaker microphone and transfers conversation to the handset.

L. Station Privacy: No patient, staff, or duty station can be remotely monitored without the lighting of a warning lamp at the monitored station.

M. Patient Station Cord Set: When a patient station cord-set plug is removed from the jack in the station faceplate, a patient station call is initiated as described above.

When the master station call button for the station is pressed, the tone stops but lights continue to flash until the call is canceled at the point of origin or the plug is reinserted or replaced with a dummy plug. Pressing and holding down the call button located on the station for a predetermined duration shall reset the station without the cord or dummy plug being inserted.

N. Patient Control Unit: Controls entertainment volume and channel selection. Speaker is used for both nurse communication and entertainment sound. Entertainment sound is automatically muted when station is communicating with master station. Nurse button on the unit initiates a patient station call.

O. Selective Paging: Master station is capable of initiating a message to selected groups of stations or speakers simultaneously by using station group switches.

P. Staff Reminder: Master station can initiate a staff reminder that a patient requires direct staff response by operating a reminder control while in contact with the patient station. This will light a distinctive-color lamp in the corridor dome light at the patient's room and in the appropriate zone lights. Reminder calls are canceled by operating a staff reminder cancel switch in the patient's room.

Q. Patient Call Priority Indication: Call priority switch near each patient station, or integral with the master station, controls the priority status of the call transmitted by individual stations. The switch selects one of the following status levels:

1. Normal: No change to the normal call initiation and canceling sequence.
2. Emergency: Call initiation produces signals and indications identical to those of emergency-call stations. Indicator lamps are extinguished and the system is reset only at the originating station.
3. Priority: System response is the same for emergency status, except voice communication between the master station and the calling station is locked in from the time of call initiation until the system is reset at the originating station.

R. Call Priority: Calls of a higher priority shall override calls of a lower priority at each master station and zone dome light. Higher priority calls shall continue annunciate uninterrupted, unless overridden by a higher priority call, until reset or cancelled at which time a lower priority call may be annunciated. The call priority shall be as listed below from lowest priority call to highest:

1. Patient Station Call
2. Staff Assistance Station Call
3. Emergency-Call/ Pull-Cord Station Call
4. Code Blue Call

2.4 EQUIPMENT DESCRIPTIONS (Audio/ Visual System)

A. Master Station: Speaker-microphone unit with operating controls.

1. Indicator lamps with legends or by liquid-crystal displays designate identification and priority of calling stations and called stations.

    a. Pulse rate of incoming-call lights denotes priority of calls awaiting response.

2. Station Selection Controls: Switches select stations for two-way voice communications.
3. Signal Tones: Announce incoming calls.

    a. Pulse rate and frequency of tone identify the highest priority call awaiting response at one time.

4. Volume Control: Regulates incoming-call volume.
5. Privacy Handset with Hook Switch: Of the type that does not require push-to-talk switch, attached to each station, unless otherwise indicated.
6. Staff Reminder Control: Initiates flashing of corresponding corridor dome lights for patients requiring service. Permits scanning equipment to indicate which patients are currently in reminder status.
7. Call Priority Selection: Controls associated with patient station selection switches determine the priority indication displayed when a call is initiated at a patient station.

B. Central Equipment Cabinet: Lockable metal. Houses amplifiers, tone generators, power supplies, controls, terminal strips, and other components.

1. Amplifier: With fidelity and overall gain necessary to achieve the sound transmission and reproduction characteristics specified, considering interoperability with the installed speakers/microphones and wiring.

    a. Power Output: Not less than 3 W at a total harmonic distortion not exceeding 5 percent.
    b. Hum and Noise: 60 dB below full output with normal input open.
    c. Volume Control: Concealed within the amplifier unit to control the volume of sound reproduced at all stations.
    d. Protection: Circuit to prevent damage to the amplifier in case shorted or open output.

2. Selective Paging Amplifiers: Plug-in card mounted in central equipment cabinet; rated 15 W.
3. System Power Supply: For 24-V dc for operation of the call system.

    a. Equipment Rating: Suitable for continuous operation between 32 and 120 deg F, from a primary line voltage between 105- to 125-V ac, 60 Hz.
    b. Output: Regulated 24-V dc with protection against overloads. Line-to-load regulation shall not exceed 2-1/2 percent with ripple and noise remaining below the 10 mV, RMS level.

c. Overload Protection: Electronic fold-back circuit set to limit the volt-ampere output to less than 100 VA during overloaded or shorted output. Restore power output automatically on removal of overload without resetting circuit breakers or replacing fuses.

4. Central Equipment Cabinet power supplies shall be hardwired to dedicated 120V circuits. Plug-in power supplies shall not be permitted.
5. Power-on indicator lamp.
6. Surge Protective Device: Comply with Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits" for auxiliary panel suppressors, with LED indicator lights for power and protection status.
7. Battery Backup Unit: Sealed nickel-cadmium, wet-cell battery supplies power through an automatic switch when normal power fails, for a period of not less than six minutes at rated output.

a. Automatic retransfer to normal power, after a 15-minute time delay.
b. Two-rate battery charger with an automatic trickle rate and a recharge rate.

C. Speaker/Microphones:

1. Type: Permanent-magnet, dynamic or ceramic, protected against dust and humidity.
2. Sound Reproduction: Sound level of 90 dB plus or minus 3 dB at a distance of 48 inches on the axis without overdriving or distorting any frequencies between 300 and 3000 Hz when installed in an enclosure or in the pillow speaker.
3. Power Handling Capacity: Not susceptible to damage from overdriving within the range of power available from the amplifier.
4. Impedance Matching: Coordinated and matched to the input and output circuits of the amplifier, both for single connection and for group monitoring, to provide the sound reproduction specified. Subsystems or components shall not be combined, which could cause unacceptable distortion such as feedback between pillow speakers and unmuted room speaker/microphone combinations. This protection shall extend throughout the entire range of operation (volume control) of all components.

D. Single-Patient Station:

1. Patient Stations are a primary point of two-way communication between patients and staff. Equipped with three call buttons and a cancel button, they offer users an easy-to-operate means of placing calls on the patient-staff communications system. With a built-in speaker and microphone, these devices also provide patients with the means of opening a full-duplex channel of audio communications with attending staff, and vice versa. On-board LEDs provide operational feedback as well as status indication.

2. Smart Patient and Staff/Duty Stations provide separate 18-pin receptacles for the connection of pillow speakers. Each station also comes equipped with a ¼" (0.64 mm) receptacle that can be programmed to accept either an input from auxiliary equipment, or a bed call cord.
3. Patient Stations shall provide a durable 18-pin pillow speaker receptacle and two user-configurable ¼" jacks for use with call cords or as non-latching device monitoring (auxiliary) inputs.
4. Stations shall provide four buttons that are field configurable allowing Owner to define call priorities without ordering custom units.
5. Patient Stations shall be available with an optional 37-pin bed interface receptacle on the front of the station, for use where bed interfaces are shown on plans, eliminating the need for separate devices.
6. Stations shall NOT require the use of "dummy" plugs for any receptacles including call cord/auxiliary device, pillow speaker, and bed interface connections. Systems requiring a dummy plug to be inserted to cancel cord out calls shall not be accepted.
7. Patient Stations must provide the ability to intentionally remove a device (call cord, pillow speaker, bed interface) without placing a call to the System. When this feature is activated, the removal of any of these items shall not send a cord out call.
8. Stations must provide a cleaning mode to allow housekeeping to clean station surfaces without generating false calls. Activating cleaning mode shall temporarily disable the front panel buttons for a configurable period of time.
9. It shall be possible to cancel a call from any cancel button within a patient room by linking stations when configured to do so and code allows.
10. Patient Stations shall be configurable for custom call types without custom ordering devices from the Manufacturer or replacing devices.
11. Patient Stations shall have separate speaker (2-inch dynamic cone) and microphone to support full duplex audio. Systems using half-duplex audio (voice operated switch) shall not be accepted.
12. Patient Stations shall include two independent auxiliary inputs (1/4" jacks) capable of supporting either latching medical equipment and/or non-latching call cords. Staff members shall be able to configure these inputs for latching or non-latching inputs at the station without removing the station from the wall. The Patient Stations shall provide a visual indication of the auxiliary input status being set.
13. Patient Stations shall have a status LED to indicate call and communication status.
14. Each Patient Station button shall have a dedicated LED to indicate that the button has been pressed or is actively indicating a call. Patient Stations using a single LED to indicate the pressing of any button will not be accepted.
15. Patient Stations shall support a staff follow mode that, when activated, alerts staff to calls from other stations by an audible tone at the station in their current location. The staff follow tone shall match the tone of the incoming call priority.

16. Patient Stations shall be hot swappable and not require system shutdown or removal of power prior to replacement.
17. Patient Stations shall support simultaneous input of pillow speaker and bed. If either connection is removed, audio must automatically transfer to the remaining device or to the on-board station speaker.
18. Volume levels for each Patient Station shall be adjustable on a station-by-station basis. Universal settings, or settings that affect an entire wing or floor, shall not be accepted.
19. All Patient Stations shall be supervised.
20. Patient Stations shall provide on-board lighting to provide visibility in dark rooms.
21. In areas where the patient station shall control any patient lighting, it shall be the responsibility of the low voltage contractor to supply, install, and terminate the control cabling routed between the patient station and the low voltage relay controlling the lighting.
22. In areas where the patient station shall control the patient television, it shall be responsibility of the low voltage contractor to supply and install the wall television plate and the control cable routed between the wall plate and the patient station. The low voltage contractor shall be responsible for all control cable terminations.

E. Dual-Patient Station: Dual-Patient stations shall meet all of the requirements of the Single-Patient station with twice as many inputs as specified on the single-patient station.

F. Staff and Duty Stations: Audible call-tone signal device, speaker microphone with 2-inch dynamic cone, monitor lamp, reset switch, routine-call lamp, emergency-call lamp, and call push button; assembled under a single faceplate.

G. Code Blue Station: Audible call-tone signal device, speaker microphone with 2-inch dynamic cone, monitor lamp, reset switch, Code Blue emergency-call lamp, and call push button; assembled under a single faceplate.

H. Ambulatory-Patient Station: Speaker microphone with 2-inch dynamic cone, monitor lamp, reset switch, call-placed lamp, and call push button; assembled under a single faceplate.

I. Selective Paging Speakers: 8-inch cone type with 1-inch voice coil and minimum 5-oz. ceramic magnet, multitap matching transformer, flush-mounting steel back-box, and white enamel-finished metal ceiling grille.

J. 37-Pin Bed Connections: In areas where the nurse call system will integrate with a Patient Bed Connection, a multi-conductor cable shall be provided between the bed locator and the patient station to.

K. Call Priority Switch Station: Three-position, tamper-resistant priority selection switch. Positions designated by labeling "Normal," "Emergency," and "Priority."

L. Staff Reminder Cancel Switch Station: Momentary contact.

2.5 MISCELLANEOUS EQUIPMENT COMPONENT DESCRIPTIONS

A. Emergency-Call Station: Button labeled “Push for Help”; reset button labeled “Cancel” and call-placed lamp; mounted in a single gang faceplate.

B. Pull-Cord Call Station: Water-resistant construction. Includes the following, mounted under a single faceplate:

1. Pull-Down Switch: Lever-locking type, labeled "Pull Down to Call Help."
2. Reset trigger.
3. Call-placed lamp.
4. Pull-Cord constructed of smooth, non-porous PVC cord. The pull cord shall hang within 2” of the floor.

C. Staff-Assistance-Call Station: Button labeled “Staff Assist”; reset button labeled “Cancel” and call-placed lamp; mounted in a single gang faceplate.

D. Dual Button Station: Two buttons: one labeled Staff Assist and one labeled Push for Help; reset button labeled “Cancel” and call-placed lamp; mounted in a single gang faceplate.

E. Patient Control Unit: Equipped with plug and 96-inch-long white cord.

1. Ethylene oxide, sterilizable.
2. Light-Control Switch: Arranged for independent on-off control of patient's up and down light.
3. Integral Speaker: 2 inches, with 0.35-oz. magnet, rated 0.2 W.
4. Controls: Speaker volume, TV control, and nurse call.
5. Housing: High-impact white plastic.
6. Attachment: Stainless-steel bed clamp with permanently attached Mylar strap.
7. Quantity: 12 units for every 10 patient beds.

F. Call-Button Cord Set: Plug and 72-inch white cord; equipped with momentary-action, call-button switch.

1. Ethylene oxide, sterilizable.
2. Washable cord.
3. Palladium switch contacts in high-impact white housing with cord-set strain relief.
4. Attachment: Stainless-steel bed clamp with permanently attached Mylar strap.
5. Quantity: 3 cord sets for every 10 patient beds.

G. Call-Button Plug: Designed to plug into patient station cord-set receptacle. Button switches call circuit. Furnish 2 plugs for every 10 patient beds.

H. Dummy Plugs: Designed to plug into patient station cord-set receptacle when call-button plug or patient cord set is not used. Furnish 3 plugs for every 10 patient beds.

I. Indicator Lamps: Light-emitting-diode type with 20-year rated life, unless otherwise indicated.

J. Station Faceplates: High-impact plastic, beige color. Molded or machine-engraved labeling identifies indicator lamps and controls.

K. Corridor Dome Lights and Zone Lights: Four-lamp signal lights.

1. Lamps: Front replaceable without tools, low voltage with rated life of 7500 hours. Barriers are such that only one color is displayed at a time.
2. Lenses: Heat-resistant, shatterproof, translucent polymer that will not deform, discolor, or craze when exposed to hospital cleaning agents.
3. Filters: Two per unit, amber and red.

L. Cable: Features include the following, unless otherwise indicated:

1. Conductors: Jacketed single and multiple twisted-pair, copper cables. Sizes and types as recommended by equipment manufacturer.
2. Cable for Use in Plenums: Listed and labeled for plenum installation.

M. Grounding Components: As specified in Division 27 Section 27 05 26 "Grounding and Bonding for Communication Systems."

2.6 NURSE CALL SYSTEM INTEGRATION

A. Interface Engine

1. Each nurse call UL 1069 Listed system/network shall connect to the hospital's network via a software bridge that isolates the hospital network from the nurse call network to maintain UL requirements. This connection to the hospital's network will allow the integration of supplemental systems including:

a. Wireless communication system(s)
b. Reporting Database
c. ADT Integration
d. Wireless Locating
e. Electronic Whiteboard
f. PC Staff Console applications
g. Patient/Staff Assignments
h. Automatic/Manual Messaging

2. This integration shall provide a single database for the entire facility, for ease of administrator maintenance.

3. This integration platform MUST be compatible with other Nurse Call Systems offered by the selected vendor to allow migration options to other Systems. A Manufacturer whose interface platform cannot be shared with their other Systems shall not be accepted.

B. Management Reporting

1. A server computer running Microsoft SQL Server and a reporting application shall reside on the hospital's network to monitor all nurse call activity and log events into the SQL database. Reporting applications that do not utilize Microsoft SQL Server shall not be acceptable. The nurse call events shall be retrievable in the form of user-defined reports. The reporting database must provide flexibility to generate reports for facility wide efficiency studies, unit performance statistics, incident report/details, and system performance/device failures.
2. Staff members shall be able to generate and view reports from any networked PC with Internet Explorer 6.0 or greater. Systems requiring staff members to go to a dedicated PC to generate or review reports, or requiring special software applications such as pcAnywhere to be loaded on PCs to provide report access, shall not be accepted.
3. The reporting database shall allow up to 25 user logins, and be expandable to 125 logins for access to generate or view reports. Systems that only allow a single user to generate or view reports at a time shall be considered unacceptable.
4. Staff shall gain access to the reporting package via a login name and password. Each staff member's password shall determine which areas within the facility the staff member can include in his or her reports.
5. The reporting system shall include a wizard that provides step-by-step instructions to the user. Help menus shall also be available so that the user does not need to refer to a hardcopy user manual for assistance.
6. The reporting system must be capable of automatically generating scheduled reports. When the report is generated, a hyperlink shall be emailed to predetermined recipients. The recipient may click on the hyperlink and log in to view the report.
7. The reporting system shall allow report templates to be defined and saved. A user shall be able to select a template for fast and simple report generation. The system shall allow 125 report templates to be set up and saved.
8. Reports shall be organized by the user to include and sort data by any or all the following categories:

    a. Time and Date-Range in days, hours, and minutes
    b. Shift-Range in hours and minutes
    c. Room/Bed Number-A range of bed numbers between four to six digits
    d. Area Name-19 characters assigned to a group of rooms
    e. Call Priority-Seven levels
    f. Event-Any combination or all nine events

g. Staff Level-Any one or all three levels
h. Patient Name-Up to 25 characters

9. Dependent on the user's report selections, a generated report shall include a statistical summary of the maximum and average times for the following event pairs at each priority level:

a. Place/Answer-The interval between the time a call is placed to the Staff Console and the time the Staff Console answers the call.
b. Place/Clear-The interval between the time a call is placed to the Staff Console and the time a staff member makes the first response by answering from the Staff Console, pressing the presence set button at the originating station, or pressing the CANCEL button at the originating station.
c. Place/Cancel-The interval between the time a call is placed to the Staff Console and the time it takes for a staff member to disconnect the call at the Staff Console (unless the reminder feature is activated), press the CANCEL button at the originating station, or press the presence clear button at the originating station.
d. Staff Console either originates or answers a call and the time the Staff Console ends the call.
e. Reminder Set/Reminder Clear-The interval between the time the reminder feature is activated for a particular room/bed number and the time the reminder feature is canceled.
f. Presence Set/Presence Clear-The interval between the time the presence feature is activated at a station and the time the presence feature is canceled.

10. The reporting system shall then take the Place/Answer, Place/Clear, Place/Cancel, and Reminder Set/Reminder Clear statistical summaries and display them in the report as a percentage in comparison to target rates determined by the administration. A percentage between 0 and 99 indicates that the staff's response time did not meet the standards set by the author of the report or the administrator of the system.
11. The reporting system shall allow each area of the facility to set target response times for each of the call priorities. Various types of exception reports shall be available to provide information about calls that were not handled within the department's target time. Systems with reporting packages that do not allow each area to set target times or to create exception reports shall not be accepted.
12. The reporting system shall record system failure signals, thereby allowing maintenance personnel to generate reports relating to system reliability and service response times.

C. Patient/ Staff Assignments

1. Staff assignment software to assign staff to wireless devices and staff to beds shall be available via client-based software. The staff assignment screens

shall be password protected. The login password shall determine the staff, beds and wireless devices available to the operator.

2. The assignment screens shall allow the user to choose whether the patient name will be displayed for each bed (requires an ADT interface), or whether each bed will simply indicate its current patient stations (occupied or empty).
3. The staff assignment software shall allow for shifts to be created ahead of time and saved so that they can be reused.
4. The staff assignment software shall provide active help to guide the user through the process (without opening a separate help screen). Help screens shall also be available for more detail instructions.
5. The staff assignment software shall provide the ability to manage float staff. The user shall be able to reassign Staff that work in various locations throughout the hospital from one unit to another without entering the staff names into multiple databases.
6. The staff assignment software must be client-based, allowing shift assignments to be completed from any networked computer in the facility. Systems requiring a dedicated PC for completion of staff assignments shall not be accepted.

D. Messaging

1. The System shall allow text messages to be sent to wireless devices from a messaging browser. Login to the browser shall be password protected.
2. The messaging software shall allow the user to send a message to a caregiver's wireless device by selecting either the caregiver's name, the caregiver's wireless device number, the number of the bed that requires assistance, or the name of the patient that requires assistance (requires ADT interface). Systems that require the user to know who is assigned to a bed/patient in order to send a message shall not be accepted.
3. The messaging software shall provide feedback to indicate that the wireless system has received the message. Systems that do not provide acknowledgment of sent messages shall not be accepted.
4. The messaging software shall be browser-based, allowing users to send messages from any networked PC with Internet Explorer. Systems that require a dedicated PC or special software loaded onto individual PCs to provide messaging access shall not be accepted.

E. Wireless Telephone Integration

1. The Nurse Call System shall allow connection to any brand of in-house wireless telephone system including wireless VoIP systems. This integration shall allow calls from patients to automatically ring the wireless device of the assigned caregiver(s). The wireless device must show the caregiver the bed number of the call, the call type/priority, and optionally either the unit name or the patient name (with presence of ADT interface).
2. The wireless telephone integration shall allow no less than three levels of staff, plus a charge nurse and a "group," to be assigned to each patient/bed

or call priority. These assignments shall be performed via the client-based assignments software. The rollover time from the primary staff member to the secondary, tertiary, and charge nurse shall be definable by the facility.

3. A call escalation manager shall manage automatic messaging to wireless devices. The call escalation manager shall also provide group page functions that allow any defined group of devices to receive any selected call type(s). When a call is sent to a group, the call escalation manager shall also provide the ability to transmit a "call cancel" in the event of a call being attended to; remaining staff not yet on-site can be notified that the situation has been attended to.
4. The wireless integration shall allow device failures in the Nurse Call System to generate an automatic call directly to a Biomed device.

F. Pocket Pager Interface

1. The Nurse Call System shall allow connection to any brand of in-house pocket pager system. This integration shall allow calls from patients to automatically send text messages to their assigned caregiver(s). The pager display must show the caregiver the bed number of the call, the call type/priority, and optionally the unit name or patient name (with presence of ADT interface).
2. The pocket pager integration shall allow no less than three levels of staff, plus a charge nurse and a "group," to be assigned to each patient/bed or call priority. These assignments shall be performed via the client-based assignments software. The rollover time from the primary staff member to the secondary, tertiary and charge nurse shall be definable by the facility.
3. A call escalation manager shall manage automatic messaging to the pocket pagers. The call escalation manager shall also provide group page functions that allow any defined group of devices to receive any selected call type(s).
4. The call escalation manager shall also provide the ability to transmit a Call Cancel in the event of a call being attended to; remaining staff not yet on-site can be notified that the situation has been attended to.
5. The pocket pager integration shall allow device failures in the Nurse Call System to generate an automatic page to a Biomed device.

G. ADT Interface

1. The System shall allow automatic monitoring of the facility's HL7 (Version 2.2/2.3) Admit, Discharge & Transfer (ADT) transactions, and shall parse selected patient demographic fields into the Nurse Call System's database. This data shall be made available to assignments, messaging, electronic white board, and reporting applications.

H. Electronic White Board

1. An electronic 'white board' shall provide automated, real-time patient and staff information. This software client shall display real-time data in a format configurable by the user. There shall be more than 40 fields of data

available to display, selectable on a per unit or login basis. Twelve of these fields must allow for on-the-fly manual entry of notes pertaining to the bed/room that remain with the room, and an additional twelve fields for notes pertaining to the patient. Notes associated with the patient must transfer with the patient when moved to another bed/unit.

2. Patient information shall automatically populate (with interface to ADT system).
3. Staff information shall automatically update from the client-based assignments software.
4. Each column displayed on the electronic white board shall sort by alphabetical or numerical order by simply clicking on the column header. Columns shall be rearranged to best meet the needs of the user via click and drag.
5. The electronic white board must allow up to 125 simultaneous logins, each having the ability to customize their screen as needed.

I. Telephone Gateway

1. The nurse call network shall be equipped with an SIP compatible device that has analog trunk ports for connection to PBX extension ports.
2. The telephone gateway shall provide access to wired telephones that are connected to the hospital's telephone system. It shall allow wired or wireless telephones to communicate with Patient and Staff Stations. The call information shall include the room and bed identification, call type, and patient name if available. The telephone gateway shall communicate using standard telephone protocols.
3. The telephone gateway shall be programmable via any PC that is connected to the network, either onsite or remotely. The gateway shall support up to 512 stations on the Nurse Call System. The gateway shall accept multiple inputs and outputs to connect to multiple Systems on site.

J. List View Client Software

1. List View Client Software shall be available to provide a list view of unit activity to supplement the Staff Console. This client shall provide information on:

    a. Pending calls
    b. Active reminders
    c. Reminder reason
    d. Staff Location (automated with presence of IR Locate)
    e. Patient record data (manually or automatically with presence of ADT Interface)
    f. Activity history per patient/bed including:

        1) Calls
        2) Audio connection to room
        3) Reminders

4) Text messages (automatic and manual)
5) Staff Arrivals

g. Nine levels of staff

2. The List View Client shall automatically expand to show room summary for the first call on the pending calls list.
3. Each List View login shall be capable of having a unique reminder reason and messaging list. Systems requiring all users to share the same remind and messaging list shall not be accepted.
4. The List View Clients shall be password protected. The login password shall determine the units visible and view preferences for each client.
5. List View Client's text colors shall be configurable to match Corridor Light settings.
6. The List View Client shall be capable of messaging a caregiver (one of three levels assigned plus charge or team) from the Map View screen
7. Staff icons shall be configurable to match their staff type via one of nine available levels/colors. Systems limited to less than nine staff types shall not be acceptable.
8. The List View Client shall be capable of running on an existing PC at the nurse station or on a PC dedicated to Nurse Call System functions. Systems requiring a dedicated PC for the functions listed shall not be accepted.

K. Map View Client Software

1. Map View Client Software shall be available to provide a map view of each nursing unit via login to supplement the Staff Console. This client shall display the following information:

a. Staff list shall sort by level, name, device type (phone/pager), and device ID
b. 3D unit map
c. Staff location via icons
d. Call activity via room color change
e. Reminder icons
f. Activity history per patient/bed including:

1) Calls
2) Audio connection to room
3) Reminders
4) Text messages (automatic and manual)
5) Staff Arrivals
6) Location list shall be sortable by level, name, location or battery status
7) Patient census list shall be sortable by patient name, bed number
8) Unique icon for mobile each device type (pager, phone, team)

9) Display bed-by-bed, three levels of assigned staff plus charge and active teams

2. Rooms shall display call location and call type. Call colors shall be configurable to match Corridor Light settings by priority.
3. It shall be capable of messaging the caregiver (one of three levels assigned plus charge or team) from the Map View screen
4. Reminder colors shall be configurable to indicate reminder and match Corridor Light settings.
5. Each Map View login shall be capable of having a unique reminder reason and message list. Systems requiring all users to share the same remind and messaging list shall not be accepted.
6. Staff presence icons shall be configurable to match staff level/type. Up to nine colors/levels shall be available.
7. The Map View shall be configurable on site using a pick and place set up wizard. Systems requiring CAD files to be imported or graphical software for creation of unit maps shall not be accepted.
8. The Map View Client shall automatically show room summary for any selected room.
9. The Map View Clients shall be password protected. The login password shall determine the units visible and view preferences for each client.
10. The Map View Client shall be capable of running on an existing PC at the nurse station or on a PC dedicated to Nurse Call System functions. Systems requiring a dedicated PC for the functions listed shall not be accepted.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wiring Method: Install wiring in conduit. Use UL-listed plenum cable in environmental air spaces including plenum ceilings. Conceal cable and raceway wiring except in unfinished spaces. All wiring shall meet or exceed UL Standard 1069.

B. Install cables without damaging conductors, shield, or jacket.

C. Do not bend cables, in handling or in installing, to smaller radii than minimums recommended by manufacturer.

D. Pull cables without exceeding cable manufacturer's recommended pulling tensions.

1. Pull cables simultaneously if more than one is being installed in same raceway.
2. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.
3. Use pulling means, including fish tape, cable, rope, and basket-weave wire or cable grips, that will not damage media or raceway.

E. Install exposed raceways and cables parallel and perpendicular to surfaces or exposed structural members, and follow surface contours. Secure and support cables by straps, staples, or similar fittings designed and installed so as not to damage cables. Secure cable at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, or fittings.

F. Wiring within Enclosures: Provide adequate length of conductors. Bundle, lace, and train conductors to terminal points with no excess. Provide and use lacing bars in cabinets.

G. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power-wiring runs. Run in separate raceways or, if exposed or in same enclosure, provide 12-inch minimum separation between conductors to speaker microphones and adjacent parallel power and telephone wiring. Provide separation as recommended by equipment manufacturer for other conductors. All nurse call cabling shall be run in a dedicated cable pathway, segregated from all other cabling.

H. Splices, Taps, and Terminations: Make splices, taps, and terminations on numbered terminal strips in junction, pull, and outlet boxes, terminal cabinets, and equipment enclosures. Install terminal cabinets where there are splices, taps, or terminations for eight or more conductors.

I. Impedance and Level Matching: Carefully match input and output impedances and signal levels at signal interfaces. Provide matching networks if required.

J. Identification of Conductors and Cables: Retain color-coding of conductors and apply wire and cable marking tape to designate wires and cables so all media are identified in coordination with system wiring diagrams. Label stations, controls, and indications using approved consistent nomenclature.

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.

2. Label exposed cables at intervals not exceeding 15 feet.
3. Prepare cable administration drawings to show building floor plans with cable administration point labeling. Identify labeling convention and show labels for terminal hardware and positions, cables, stations and devices and equipment grounding conductors.

3.2 EXISTING SYSTEMS

A. Examine existing systems for proper operation, compatibility with new equipment, and deficiencies. If discrepancies or impairments to successful connection and operation of interconnected equipment are found, report them and do not proceed with installation until directed. Schedule existing systems' examination so there is reasonable time to resolve problems without delaying construction.

3.3 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other signal impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding except at connection to main building ground bus.

C. Grounding Provisions: Comply with requirements in Division 27 Section 27 05 26 "Grounding and Bonding of Communication Systems."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Test Procedure: Comply with the following:

1. Schedule tests a minimum of seven days in advance of performance of tests.
2. Report: Submit a written record of test results.
3. Operational Test: Perform an operational system test, and demonstrate proper operations, adjustment, and sensitivity of each station. Perform tests that include originating station-to-station and all-call messages and pages at each nurse call station. Verify proper routing, volume levels, and freedom from noise and distortion. Test each available message path from each station on the system. Meet the following criteria:

    a. Speaker Output: 90 dB plus or minus 3 dB, 300 to 3000 Hz, reference level threshold of audibility 0 dB at 0.02 millipascals of sound pressure.
    b. Gain from patient's bedside station to nurse station, with distortion less than 65 dB (plus or minus 3 dB, 300 to 3000 Hz).
    c. Signal-to-Noise Ratio: Hum and noise level at least 45 dB below full output.

4. Test Procedure:

    a. Frequency Response: Determine frequency response of two transmission paths by transmitting and recording audio tones.
    b. Signal-to-Noise Ratio: Measure the ratio of signal to noise of the complete system at normal gain settings, using the following procedure: Disconnect a speaker microphone and replace it in the circuit with a signal generator using a 1000-Hz signal. Measure the ratio of signal to noise and repeat the test for four speaker microphones.

c. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 300, 400, 1000, and 3000 Hz into each nurse call equipment amplifier, and measure the distortion in the amplifier output.

C. Retesting: Rectify deficiencies indicated by tests and completely retest work affected by such deficiencies at Contractor's expense. Verify by the system test that the total system meets these Specifications and complies with applicable standards. Report results in writing.

D. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.

E. State Inspections: A factory authorized technician shall be present at all State Inspections of the nurse call system to correct any deficiencies found during the inspection.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sound levels and controls to suit actual occupied conditions. Provide up to three visits to Project during other-than-normal operating hours for this purpose at no additional cost to the Owner.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel and caregiver staff to adjust, operate, and maintain nurse call equipment. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

DIVISION 28

ELECTRONIC SAFETY AND SECURITY

SECTION 28 05 00 - COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Low voltage electrical equipment coordination and installation.
2. Access Panels
3. Common low voltage electrical installation requirements.

1.3 DEFINITIONS

A. Code. National, State and Local Electrical codes including OSHA requirements.

B. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

C. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

D. Electrical ductbank: Assembly consisting of multiple electrical conduits embedded in earth or concrete.

E. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

F. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

G. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

H. Home Run: The portion of a branch circuit between the serving panelboard and the first electrical outlet, lighting fixture, or other electrical load connected to the circuit.

I. Provide. Used within these sections “provide” shall mean “furnish and install.” “Furnish” shall mean “to purchase and deliver to the project site complete with every necessary appurtenance and support,” and “install” shall mean “to unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project.”

J. Low voltage: 50 to 600 volts.

K. Medium voltage: 601 to 35,000 volts.

L. High voltage: 35,001 volts and greater.

M. Signal voltage: NEC class 1, 2, or 3 remote control, signaling, or power limited circuits.

1.4 SCOPE

A. Drawings and Specifications form complementary requirements; provide work specified and not shown, and work shown and not specified as though explicitly required by both. Although work may not be specifically shown or specified, provide supplementary or miscellaneous items, appurtenances, devices, and materials obviously necessary for a sound, secure and complete installation.

B. It is the intent that these Specifications and associated Drawings establish minimum requirements for products and equipment with the intent to provide electrical service, distribution and systems finished, tested and ready for operation. Incidental detail that is not shown or specified, but necessary for proper installation and operation shall be included in the work and in these Contractor's estimates, the same as if specified. Locations of all equipment and material shall be adjusted at no extra cost to the Owner, to accommodate the work interferences anticipated and/or encountered. Prior to installation, determine the exact route and location of each raceway and piece of equipment to minimize conflicts with other trades.

C. This project will be phased, as defined by the Owner. This may necessitate the provision of temporary electrical utilities. All associated appurtenances with the utilities shall be provided as part of this project in the appropriate phase coordinated with Owner’s phasing requirements.

D. Information and components shown on riser diagrams but not shown on plans, and vice versa, shall be provided as if expressly required on both.

E. Except where modified by a specific notation to the contrary, it shall be understood that the indication and/or description of any item, in the drawings or specifications or both, carries with it the instruction to furnish and install the item, regardless of whether or not this instruction is explicitly stated as part of the indication or description.

F. Items referred to in singular number in Contract Documents shall be provided in quantities necessary to complete work.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than 0 deg F (minus 18 deg C) or exceeding 104 deg F (40 deg C).
2. Humidity: Less than 95 percent (noncondensing).
3. Altitude: Not exceeding 6600 feet (2000 m), or 3300 feet (1000 m) if equipment includes solid-state devices.

1.6 MODIFICATIONS IN LAYOUT

A. Drawings are intended to outline the scope of work required and are not intended to be installation drawings. Drawings are not intended to be absolutely precise; they are not intended to specify or to show every offset, fitting, and component nor do they show the exact routing and locations needed to coordinate with structure and other trades and to meet Architectural requirements. The purpose of the drawings is to indicate a systems concept, the main components of the systems, and the approximate geometrical relationships. Based on the systems concept, the main components, and the approximate geometrical relationships, the contractor shall provide all other components and materials necessary to make the systems fully complete and operational.

B. Unless specifically stated to the contrary, no measurement of a technology drawing derived by scaling shall be used as a dimension to work by. Dimensions noted on the technology drawings are subject to measurements of adjacent and previously completed work. Measurements shall be performed prior to the actual installation of equipment.

C. Prior to installation of visible material and equipment (including access panels) in finished spaces, review Architectural Drawings for desired locations and where not definitely indicated, request information from Architect.

D. Check Contract Documents, as well as, Submittals and Shop Drawings of all subcontractors to verify and coordinate spaces in which work of Divisions 21 through 28 will be installed.

E. Make reasonable modifications in layout and components needed to prevent conflict with work of other trades. Systems shall be run parallel with or perpendicular to major architectural and structural building elements.

F. Where conflicts or potential conflicts exist and engineering guidance is desired, submit sketch of proposed resolution to Architect for review and approval.

1.7 COORDINATION

A. Coordinate arrangement, mounting, and support of communications equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of installation and removal of the equipment with minimum interference to other installations or equipment.

B. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

1.8 COORDINATION DRAWINGS

A. When included as part of the Contract Documents, there shall be full cooperation and coordination of all specialty trades.

B. This Division's contractors shall comply fully with the requirements set forth in the Division 23 Section "Coordination Drawings" specification section.

1.9 RECORD DOCUMENTS

A. Record Drawings are specified in Division 01 Section "Project Record Documents."

B. The Low Voltage Contractor shall keep a detailed up-to-date record, of the manner and location in which installations are actually made, indexing each drop, backbone, pull box and equipment / racks. Record documents are to reflect all changes in work including change orders, field directives, addenda from bid set of Contract Documents, request for information responses, etc. Upon completion of the project, the contractor shall modify the project electronic drawing and specification files to incorporate this information. Modified documents shall be turned over to the Owner and Engineer in both electronic and hard paper copy formats. Record drawings shall also include:

1. Locations of buried conduit or similar items. Include buried depth.
2. Field changes of dimension or detail.
3. Changes made by field order or change order.
4. Details not on original contract drawings.

C. As Built Drawings – Refer to the individual Division 28 Specification Section for As-Built Drawing requirements.

D. In the event of a conflict between the drawings and specifications, this Contractor shall base their bid on the greater quantity, cost or quality of the item in question, unless conflict is resolved by an addendum.

E. Take photographs of all concealed equipment in gypsum board ceilings, shafts, underground (buried) piping routes and supports and other concealed, inaccessible work. At completion of work, make copies of photographs with written explanation for each photo. These shall become part of Record Documents.

F. Underground and utility work shall be located by distances to landmarks, such as building foundations. Give actual dimensions of everything installed including elevations and elevations at each change in direction.

G. Drawings shall also show record condition of details, sections, riser diagrams, control changes and corrections to schedules. Schedules shall incorporate actual manufacturer and make and model numbers of final equipment installation.

H. THE ENGINEER/ARCHITECT WILL NOT CERTIFY THE ACCURACY OF THE RECORD DRAWINGS - THIS IS THE SOLE RESPONSIBILITY OF THE CONTRACTOR.

I. When required by the jurisdiction, each trade shall submit the record set for approval by the building department in a form acceptable to the department. Any document format size changes, and supplemental information required for the submittal are the responsibility of the contractor.

J. Quality of Record Documents shall equal or exceed that of original Contract Documents.

K. The record documents shall be submitted in electronic media format to the Architect/Engineer for review and approval, prior to Application for Final Payment.

1.10 MAINTENANCE MANUALS AND OPERATING INSTRUCTIONS

A. Obtain at time of purchase of equipment, three copies of operation, lubrication, and maintenance manuals for all items. Assemble literature in a coordinated manual using loose leaf sheets in a three-ring binder(s). Manual shall contain names and addresses of manufacturers and local representatives who stock or furnish repair parts for items or equipment.

B. The manuals shall include the following and shall have an index of contents and tabs for each Specification Section and each piece of equipment specified in that Section and be provided in the order listed below, per Specification Section.

1. Copies of all approved submittals/shop drawings.
2. Manufacturer's operating and maintenance instructions and parts lists of all items or equipment. Where manufacturer's data includes several types or models, the applicable type or model shall be clearly designated.
3. Startup and shutdown procedures.
4. Test records.
5. Wiring diagrams.
6. Lubrication instructions detailing type of lubricant, amount, and intervals recommended by manufacturer for each item of equipment.

7. Owner's written acknowledgement of satisfactory completion of instruction period.

C. Furnish three copies of manuals to Architect for approval and distribution to Owner. Deliver manuals no less than 30 days prior to acceptance of equipment to permit Owner's personnel to become familiar with equipment and operation prior to acceptance.

D. Operating instructions: Upon completion of installation or when Owner accepts portions of building and equipment for operational use, instruct Owner's operating personnel in any or all parts of all systems. Factory-trained personnel shall perform instructions.

1.11 SUBMITTAL PROCEDURE AND FORMAT

A. This Article supplements Division 1.

B. Submittal Cover Sheet

1. Submittal data for each product shall include a copy of the following cover sheet completely filled out. Incomplete or incorrect cover sheet submittal shall constitute reason for rejection.
2. Material submittals shall be organized by specification section. All items requiring a submittal per each specification section shall be combined into a single submittal. Provide each section/item within that submittal with its own cover sheet labeled and tagged to match the drawings.

SHOP DRAWING COVER SHEET				
PROJECT:		CONTRACTOR:		
DIVISION NO.:		SECTION NO.:		
DESCRIPTION:				
CONTRACT DRAWING REFERENCE NO:				
EQUIPMENT TAG:				
SUBMISSION (CIRCLE ONE): FIRST, SECOND, THIRD, FOURTH				
DATE:				
INFORMATION AND CHECKLIST				
1.	Contractor's Log #ID			
2.	Name, address, and phone number of supplier.			
3.	Are all specified or scheduled items included and exactly match scheduled/specified items?	Yes	No	
4.	Is this item a substitution?	Yes	No	
5.	Are deviations clearly identified?	Yes	No	
6.	Does equipment fit space shown on construction documents, coordination drawings, and actual field conditions?	Yes	No	
7.	Has support, erection, weights, and installation been coordinated with all trades?	Yes	No	
8.	Does the proposed installation void warranties and/or violate UL or code requirements?	Yes	No	
9.	Does this material/equipment add expense to any other trade or project costs?	Yes	No	
10.	Does equipment require interface with other trades? List divisions and specifics requiring coordination?	Yes	No	
11.	Is control interface coordinated?	Yes	No	
12.	List electrical characteristics (V/Ph/A)			

3. Multiple Re-submittals: The Engineer will review the first submittal from the contractor and respond with comments and will review one re-submittal for the same item(s) from the contractor and respond with comments. If the contractor is required to make subsequent submittals for the same item(s) the Engineer shall be compensated by the contractor for the time to review each subsequent re-submittal. The contractor shall agree to compensate the Engineer a minimum of $500 per each re-submittal item.
4. Shop Drawings showing layouts of systems shall contain sufficient plans, elevations, sections, details and schematics to describe work clearly. They shall be 1/4 inches = 1 foot 0 inch scale unless specified otherwise.
5. Shop drawings and submittals showing manufacturer's product data shall contain detailed dimensional drawings, accurate and complete description of materials of construction, manufacturer's published performance characteristics and capacity ratings (performance data, alone, is not acceptable), electrical requirements and wiring diagrams. Drawings shall clearly indicate location (terminal block or wire number), voltage and function for all field terminations, and other information necessary to demonstrate compliance with all requirements of Contract Documents.
6. Provide shop drawing submittals showing details of electrical connections to ALL equipment. If connection details are not submitted and connections are found to be installed incorrectly in the field, this contractor shall reinstall them within the original contract price.
7. Shop drawings for different systems and equipment shall be bound separately by specification section as indicated above and not bound by manufacturer. Each separate submittal shall have its own transmittal and cover letter. Submittals which contain different specification section systems bound together shall be returned un-reviewed for re-submittal.

1.12 QUALITY ASSURANCE

A. Acceptable Manufacturers

1. The Engineer’s design for each product is based on the manufacturer listed in the schedule or shown on the drawings. In Part 2 of some technical specifications, other manufacturers are listed as being acceptable. The listing of a manufacturer as acceptable does not imply automatic approval. It is the sole responsibility of the Contractor to ensure that any submittals made are for products that meet or exceed the specifications included herein. These are acceptable only if, as a minimum, they:

   a. Meet all performance criteria listed in the schedules and outlined in the specification.
   b. Have identical operating characteristics to those called for in the specification. For example, a two-post equipment rack will not be acceptable if a four-post model is specified.
   c. Fit within the available space it was designed for, including space for maintenance and component removal, with no modification to either

the space or the product. Clearances to walls, ceilings and other equipment will be at least equal to those shown on the design drawings. The fact that a manufacturer's name appears as acceptable shall not be taken to mean that the Engineer has determined that the manufacturer's products will fit within the available space - this determination is solely the responsibility of the contractor.

d. Products must adhere to all architectural considerations including but not limited to: being of the same color as the product scheduled or specified, fitting within architectural enclosures and details, and for diffusers, lighting and plumbing fixtures - being the same size and of the same physical appearance as scheduled or specified products.

B. All equipment shall be labeled or listed by the National Board of Underwriters Laboratories (U.L.) or other recognized listing/testing agency where such labeling or listing exists for such material.

C. All technology components, devices and accessories shall be listed and labeled as defined in the California Electrical Code (CEC), by a testing agency acceptable to authorities having jurisdiction, and marked for intended use. Skid-mounted or packaged assemblies shall be listed and labeled as an assembly, not just the individual components.

D. Work shall be installed in accordance with BICSI, IEEE, ANSI, and TIA standards.

1.13 UTILITY CHARGES

A. Include utility fees and charges for any temporary voice, data and CATV services.

B. Include utility fees and charges for any required work by the voice, data and CATV service providers for the completion of the project.

C. Utility costs for permanent service shall be paid by the Owner.

1.14 TEMPORARY/ CONTINUITY OF UTILITY SERVICES

A. Refer to Division 1 - General Requirements, regarding specific requirements.

B. Provide temporary services where project construction schedule requires extended shutdowns of existing equipment and/or systems. Temporary services include the necessary equipment and/or systems to maintain continuity of services. Extended shutdowns are interruptions of existing services for a period of time longer than that acceptable to the Owner.

C. Do not interrupt existing utility services without written Owner's approval.

D. Schedule interruptions in advance, according to Owner's instructions. Submit, in writing, with request for interruption, methods proposed to minimize length of interruption.

E. Interruptions shall be scheduled at such times of day and work so that they have minimal impact on Owner's operations.

F. Contractor shall coordinate any shutdowns of existing systems as follows:

1. Give proper notice to Owner when making shutdowns; a minimum of fourteen full days is required.
2. Minimize timeline of shutdowns of any system.
3. Provide temporary services where required and perform shutdowns and tie ins at a time convenient to Owner.
4. Contractor shall be responsible for completing and filing the Owner's shutdown notice questionnaire.
5. Perform required survey and inspection work required by the notice for shutdown.

G. Provide all necessary material, tools, and labor as required for the provisions of temporary services.

H. Include premium time work associated with interruptions of services and/or shutdowns as necessary to avoid disruption to Owner's operations.

I. For communications work associated with any service provider, coordinate with the appropriate service provider.

J. Complete the following form, indicating what is being included as part of this bid, and this project.

K. For work involving an independent utility company (i.e., non-owner provided utility), Contractor shall coordinate directly with the utility provider all aspects of related work, including shutdowns, tie-ins, capacity impacts, etc.

1.15 DELIVERY, STORAGE, AND HANDLING

A. Protect equipment/materials from damage during shipping, storage, handling, and installation. Delivery equipment/materials to the site in manufacturer’s original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

B. The Contractor shall provide for enclosed storage, when equipment/materials are stored on-site and prior to building “dry-in”, to prevent any damage resulting from inclement weather or construction traffic. Specialties shall not be stored outdoors.

C. Equipment/materials, stored or installed, found to be damaged shall be replaced with new by the Contractor, to the satisfaction of the Owner and at no additional

expense. Do not store equipment with PVC material with exposure to direct sunlight.

D. Equipment exposed to weather during shipping and/or storage on site shall be plastic shrink-wrapped by the manufacturer to prevent damage due to weather and road debris during transportation and thereafter while in storage awaiting installation.

E. Prevent dirt and construction debris from accumulating inside equipment (including pipe and conduit, ductwork, fittings, etc.).

F. Equipment/materials shall be handled and installed in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 CEILING ACCESS AND ACCESS PANELS

A. Access panels are generally not shown on the drawings, but they are required to be provided by Contractor.

B. Access panels shall be of size required to provide adequate access to equipment. Minimum size shall be 12" X 12" for hand access or 24" X 24" for body access. Minimum 16-gauge frame, not less than 18-gauge hinged door panel. Door locks shall be screwdriver operated for panels in general location applications and shall be key locked for public area applications.

C. Furnish access panels for installation under other Sections valves or other items installed under this Division require access and are concealed in floor, wall, furred space or above ceiling. Access panels shall be by Milcor, Knapp, Nystorm or Inland Steel; coordinate selection with other Sections supplying similar access panels. Color of panel shall be selected by the Architect.

D. Panels shall include concealed hinges, cam type locking devices, and shall have a frame border type necessary for the particular wall or ceiling construction in which they are installed. Access panels shall be flush mounted, recessed frame type units. Access panels shall be prime coated steel, for field painting for general applications and stainless steel for use in toilet rooms, shower rooms, and similar wet locations.

E. Access panels shall have same fire rating classification as surface penetrated. Rated access panels must have U.L. Label.

2.2 FLASHING MATERIALS

A. All piping, conduit and equipment supports through roofs shall be flashed. Flashing materials and methods shall be in accordance to the roof manufacturer's and Division 07 requirements.

PART 3 - EXECUTION

3.1 PRE-BID SITE VISIT

A. Before submitting bid, visit and carefully examine site to identify existing conditions and difficulties that will affect work of Division 28. No extra payment will be allowed for additional work caused by unfamiliarity with site conditions that are visible or readily construed by an experienced observer.

B. The Low Voltage Contractor shall visit job site to familiarize himself with the specific location of the new equipment installations in existing areas, to ensure there is adequate access for the installation of equipment. All entries, pathways, corridors, stairwells, etc., that may be used to install equipment shall be investigated. All existing conditions and potential obstructions that may impede access and installation shall be addressed prior to equipment purchasing/ordering.

C. The documentation of existing conditions was derived from As-Built documents and are in part unverified. Actual existing conditions shall be verified prior to commencement of work.

3.2 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

F. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions,

ceilings, and floors at pipe, conduit and wiring penetrations. Seal penetrations with fire- and smoke-stop materials. Refer to Division 07 for firestopping and fill materials.

G. Waterproof Penetrations: Maintain integrity of waterproof roof, wall and floor penetrations for pipe, conduit, and equipment support penetrations. Seal penetrations with waterproof materials with clamps, sleeves, flashings, pipe boots and/or pipe curb assemblies as detailed or specified. Refer to Division 07 for waterproofing methods and materials when not specified in this section.

3.3 FIREPROOFING

A. Clips, hangers, clamps, supports and other attachments to surfaces to be fireproofed shall be installed, insofar as possible, prior to start of spray fiber work.

B. Piping and other items which would interfere with proper application of fireproofing shall be installed after completion of spray fiber work.

C. Patching and repairing of fireproofing due to cutting or damaging to fireproofing during course of work specified under this Section shall be performed by installer of fireproofing and paid for by trade responsible for damage and shall not constitute grounds for extra cost to Owner.

3.4 INSTALLATION ONLY ITEMS

A. Where this contractor is required to install items which he does not purchase, he shall coordinate their delivery and be responsible for their unloading from delivery vehicles and for their safe handling and field storage up to the time of installation. This contractor shall be responsible for:

1. Any necessary field assembly and internal connections, as well as mounting in place of the items, including the purchase and installation of all dunnage supporting members and fastenings necessary to adapt them to architectural and structural conditions.
2. Their connection to building systems including the purchase and installation of all terminating fittings necessary to adapt and connect them to the building systems.

B. This Contractor shall carefully examine such items upon delivery. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of work of this Contractor will be considered only if presented in writing within one week of their date of delivery. Unless such claims have been submitted, this Contractor shall be fully responsible for the complete reconditioning or replacement of the damaged items.

3.5 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.

G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pathway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pathway or cable and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 CLEANING AND PAINTING

A. Rubbish resulting from this work shall be removed and disposed of on a daily basis in a manner as to be acceptable to the Architect.

B. The Low Voltage Contractor shall clean exposed work and equipment, the interior and exterior of cabinets and pull boxes, etc., and remove rubbish and debris resulting from the work.

C. Where painted surfaces of equipment have been damaged or rusted during construction, the Low Voltage Contractor shall repair and paint to match original finish.

D. Clean other equipment indicated in other sections of the specification for specific equipment.

E. Cleaning shall be performed prior to system start-up.

F. Equipment

1. After completion of project, clean the exterior surface of all equipment, including concrete residue, dirt, paint residue, etc.

3.8 OWNER TRAINING

A. As part of this contract, the contractor shall include all labor and materials to train the building Owner on the electrical systems installed. The contractor shall be responsible for video and audio taping of all Owner training.

B. Owner training shall adhere to the training specified in each Division 28 Specification Section.

C. In general, training shall cover all aspects of the operation and human interface with the given system. Training shall include, but not be limited to:

1. General description of the system and operating intent.

2. Review and demonstration of all adjustments and programming available to the customer.
3. Review of all system display screens and annunciation functions, both audible and visual.
4. Review and demonstration of all required and recommended periodic system/equipment maintenance. Review shall include all required lockout and tagging procedures.
5. Refer to individual specification sections for additional requirements associated with Owner training.

3.9 COMMISSIONING

A. The Commissioning Authority will be Owner furnished and under direct contract with the Owner. That is, the General Contractor and this subcontractor's bid price shall not include the services of the Commissioning Authority but shall include costs for coordination testing, Contractor commissioning, etc.

3.10 CONTAINMENT ROOM SEALING REQUIREMENTS

A. General

1. Work that penetrates or is mounted on ceilings, walls, floors or other surfaces throughout containment rooms shall be sealed as outlined below in addition to sealing specified elsewhere in the Specifications.
2. Completely seal the perimeter joints around all insulated and uninsulated penetrations and surface-mounted items.

B. Products

1. Acceptable sealant materials shall be products that conform to ASTM C920 "Specifications for Elastomeric Joint Sealants". Sealant shall adhere to substrates and maintain seal under normal expected movements of substrates.
2. Sealant specified herein shall be 732-RTV silicone rubber as manufactured by Dow Chemical Co. or equivalent by GE. Color shall be clear.

C. Installation

1. Preparation, priming (as applicable), application, curing and protection of the sealant shall be in conformance with the recommendations of the sealant manufacturer.
2. If necessary, fill voids with backer rods as recommended by the sealant manufacturer.
3. Mask edges of exposed joints if required to make neat joints and prevent excessive misplacement of sealant onto exposed surfaces adjacent to joints.
4. Perform sealant work after adjacent painting work is complete and dry.

5. Sealant shall be free of voids, be applied in one continuous bead and be tooled concave and smooth.

END OF SECTION

SECTION 28 05 13 – CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 RELATED WORK AND REQUIREMENTS <Edit for Sections being issued.>

A. Section 26 05 26 – Grounding and bonding for Electrical Systems

B. Section 26 05 33 – Raceway and Boxes for Electrical Systems

C. Section 28 05 00 – Common Work Results for Electronic Safety and Security

D. Section 28 13 00 – Electronic Access Control (EAC) Systems

E. Section 28 16 00 – Intrusion Detection System

F. Section 28 16 43 – Perimeter Security System

G. Section 28 23 00 – Video Security Systems

H. Section 28 23 13 – Video Surveillance Control, Management and Recording Systems

1.3 SUMMARY

A. Section Includes:

1. Pathways including J-Hooks and Wire Basket Tray
2. UTP cabling.
3. 50/125-micrometer, multimode optical fiber cabling.
4. Single Mode optical fiber cabling.
5. Coaxial cabling.
6. RS-232 cabling.
7. RS-485 cabling.
8. Low-voltage control cabling.
9. Control-circuit conductors.
10. Fire alarm wire and cable.
11. Identification products.

1.4 REFERENCES

A. ANSI/NFPA 70 – National electrical Code

B. ASTM B633 – Specification for Electrodeposited Coatings of Zink on Iron and Steel

C. ASTM A653 – Specification for Steel Sheet, Zink-Coated (Galvanized) by the Hot Dip Process

D. ASTM A123 – Specification for Zink (Hot Galvanized) Coatings on Iron and Steel

E. ASTM A510 – Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel

F. NEMA VE 1-1998- Metallic Cable Tray Systems

G. NEMA VE 2-2000 – Cable Tray Installation Guidelines

H. NEC Compliance - (Article 318) Construction and Installation of Cable Tray

I. UL Compliance - Provide products that are UL-classified and labeled

J. BICSI Telecommunications Distribution Methods Manual

1.5 DEFINITIONS

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.

B. BICSI: Building Industry Consulting Service International.

C. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel section.

D. EMI: Electromagnetic interference.

E. IDC: Insulation displacement connector.

F. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

G. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

H. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).

I. RCDD: Registered Communications Distribution Designer.

J. Solid-Bottom or Nonventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal side rails, and a bottom without ventilation openings.

K. Trough or Ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal rails and a bottom having openings sufficient for the passage of air and using 75 percent or less of the plan area of the surface to support cables.

L. UTP: Unshielded twisted pair.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.

1. For coaxial cable, include the following installation data for each type used:

a. Nominal OD.
b. Minimum bending radius.
c. Maximum pulling tension.

B. Shop Drawings: Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

1. Vertical and horizontal offsets and transitions.
2. Clearances for access above and to side of cable trays.
3. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
4. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

C. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

D. Source quality-control reports.

E. Field quality-control reports.

F. Maintenance Data: For wire and cable to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25
2. Smoke-Developed Index: 50

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical-fiber flashlight or optical loss test set Insert test.
2. Test optical fiber cable on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; include the loss value of each. Retain test data and include the record in maintenance data.
3. Test each pair of UTP cable for open and short circuits.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install UTP, optical fiber, and coaxial cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 RESPONSIBILITIES

A. The Electrical Contractor shall be responsible for providing all back-boxes, pull-boxes, junction boxes, conduit, and sleeves as indicated in the plans and specifications to support the low voltage systems.

B. The Low Voltage Contractor shall be responsible for coordinating installation with general contractor and other trades on the job to insure all cabling is not impeding other system installations.

C. The term Low Voltage Contractor as used in this document refers to the company, group, or individual that has contract responsibility for implementing the terms and directives used in this specification document to produce the finished product as described here-in.

D. The Low Voltage Contractor for this project shall be contracted by theGeneral Contractor/Electrical Contractor.

PART 2 - PRODUCTS

2.1 RS-232 CABLE

A. Acceptable Manufacturers:

1. Belden CDT Inc.; Electronics Division.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Plastic insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. Plastic jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
6. Flame Resistance: Comply with NFPA 262.

2.2 RS-485 CABLE

A. Acceptable Manufacturers:

1. Belden CDT Inc.; Electronics Division.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262, Flame Test.

2.3 ACCESS CONTROL CABLE

A. Acceptable Manufacturers:

1. Belden CDT Inc.; Electronics Division.

B. Low-voltage control cable shall be sequentially marked at two-foot intervals.

C. Low-voltage control cabling shall be banana-peel composite cabling.

D. Plenum-Rated, Paired Lock Cable: NFPA 70, Type CMP.

1. 1 pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors.
2. PVC insulation.

3. Shielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

E. Plenum-Rated Lock Cable: NFPA 70, Type CMP.

1. 4 No. 16 AWG, stranded (19x29) tinned copper conductors.
2. PVC insulation.
3. Shielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

F. Plenum-Rated, Paired Reader Cable: NFPA 70, Type CMP.

1. 3 pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Shielded.
4. Plastic jacket.
5. Flame Resistance: NFPA 262, Flame Test.

G. Plenum-Rated Door Contact Cable: NFPA 70, Type CMP.

1. 2 No. 18 AWG, stranded (19x30) tinned copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Shielded.
4. Plastic jacket.
5. Flame Resistance: NFPA 262, Flame Test.

H. Plenum-Rated Request-to-Exit/ Spare Cable: NFPA 70, Type CMP.

1. 4 No. 18 AWG, stranded (19x30) tinned copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Shielded.
4. Plastic jacket.
5. Flame Resistance: NFPA 262, Flame Test.

2.4 IDENTIFICATION PRODUCTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Brady Corporation
2. HellermannTyton.
3. Kroy LLC.
4. Panduit Corp.

B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP and optical fiber cables on reels according to TIA-568-B.1.

C. Factory test UTP cables according to TIA-568-B.2.

D. Factory test multimode optical fiber cables according to TIA-526-14-A and TIA-568-B.3.

E. Factory sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.

F. Cable will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA-569-A-7.

B. Comply with TIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

C. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." for installation of conduits and wireways.

D. Install manufactured conduit sweeps and long-radius elbows whenever possible.

E. Pathway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits **[**3 inches**]** Insert dimension above finished floor.

5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

F. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
9. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.

D. Optical Fiber Cable Installation:

1. Comply with TIA-568-B.3.
2. Cable shall be terminated on connecting hardware that is rack or cabinet mounted.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1525 mm) apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 72 inches long shall be neatly coiled not less than 12 inches (300 mm) in diameter below each feed point.

G. Outdoor Coaxial Cable Installation:

1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches.

H. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (75 mm).
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.3 CONNECTIONS

A. Comply with requirements in Division 28 Section "Perimeter Security Systems" for connecting, terminating, and identifying wires and cables.

B. Comply with requirements in Division 28 Section "Intrusion Detection" for connecting, terminating, and identifying wires and cables.

C. Comply with requirements in Division 28 Section "Access Control" for connecting, terminating, and identifying wires and cables.

D. Comply with requirements in Division 28 Section "Video Surveillance" for connecting, terminating, and identifying wires and cables.

E. Comply with requirements in Division 28 Section "PLC Electronic Detention Monitoring and Control Systems" for connecting, terminating, and identifying wires and cables.

F. Comply with requirements in Division 28 Section "Fire Detection and Alarm" for connecting, terminating, and identifying wires and cables.

G. Comply with requirements in Division 28 Section "Refrigerant Detection and Alarm" for connecting, terminating, and identifying wires and cables.

3.4 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."

B. Comply with TIA-569-A, "Firestopping" Annex A.

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.5 GROUNDING

A. For communications wiring, comply with ANSI-J-STD-607-D and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. For low-voltage wiring and cabling, comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

3.6 IDENTIFICATION

1. Identify system components, wiring, and cabling complying with TIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Visually inspect UTP and optical fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-B.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross connection.

a. Test instruments shall meet or exceed applicable requirements in TIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

4. Optical Fiber Cable Tests:

a. Test instruments shall meet or exceed applicable requirements in TIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

b. Link End-to-End Attenuation Tests:

1) Multimode Link Measurements: Test at 850 or 1300 nm in 1 direction according to TIA-526-14-A, Method B, One Reference Jumper.

2) Attenuation test results for links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA-568-B.1.

5. Coaxial Cable Tests: Comply with requirements in Division 27 Section "Master Antenna Television System."

D. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION

SECTION 28 05 28 – PATHWAYS AND EQUIPMENT RACKS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 RELATED WORK AND REQUIREMENTS Edit for Sections being issued.

A. Section 26 05 26 – Grounding and bonding for Electrical Systems

B. Section 26 05 33 – Raceway and Boxes for Electrical Systems

C. Section 28 05 00 – Common Work Results for Electronic Safety and Security

D. Section 28 05 13 – Conductors and Cables for Electronic Safety and Security

E. Section 28 13 00 – Electronic Access Control (EAC) Systems

F. Section 28 16 00 – Intrusion Detection System

G. Section 28 16 43 – Perimeter Security System

H. Section 28 23 00 – Video Security Systems

I. Section 28 23 13 – Video Surveillance Control, Management and Recording Systems

J. Section 28 50 00 – Infant Protection Systems

1.3 SUMMARY

A. Section Includes:

1. Pathways including J-Hooks, Wire Basket Tray, Conduit and Sleeves.
2. Free standing and Wall Mounted Equipment Racks.

1.4 REFERENCES

A. ANSI/NFPA 70 – National electrical Code

B. ASTM B633 – Specification for Electrodeposited Coatings of Zink on Iron and Steel

C. ASTM A653 – Specification for Steel Sheet, Zink-Coated (Galvanized) by the Hot Dip Process

D. ASTM A123 – Specification for Zink (Hot Galvanized) Coatings on Iron and Steel

E. ASTM A510 – Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel

F. NEMA VE 1-1998- Metallic Cable Tray Systems

G. NEMA VE 2-2000 – Cable Tray Installation Guidelines

H. NEC Compliance - (Article 318) Construction and Installation of Cable Tray

I. UL Compliance - Provide products that are UL-classified and labeled

J. BICSI Telecommunications Distribution Methods Manual

1.5 DEFINITIONS

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.

B. BICSI: Building Industry Consulting Service International.

C. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel section.

D. EMI: Electromagnetic interference.

E. IDC: Insulation displacement connector.

F. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

G. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

H. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).

I. RCDD: Registered Communications Distribution Designer.

J. Solid-Bottom or Nonventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal side rails, and a bottom without ventilation openings.

K. Trough or Ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal rails and a bottom having openings sufficient for the passage of air and using 75 percent or less of the plan area of the surface to support cables.

L. UTP: Unshielded twisted pair.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.

1. For coaxial cable, include the following installation data for each type used:

a. Nominal OD.
b. Minimum bending radius.
c. Maximum pulling tension.

B. Shop Drawings: Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

1. Vertical and horizontal offsets and transitions.
2. Clearances for access above and to side of cable trays.
3. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
4. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

C. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

D. Source quality-control reports.

E. Field quality-control reports.

F. Maintenance Data: For wire and cable to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: **25Insert value** or less.
2. Smoke-Developed Index: **50450Insert value** or less.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use **[optical-fiber flashlight][or][optical loss test set]. <Insert test.>**
2. Test optical fiber cable on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; include the loss value of each. Retain test data and include the record in maintenance data.
3. Test each pair of UTP cable for open and short circuits.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install UTP, optical fiber, and coaxial cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 RESPONSIBILITIES

A. The **[Low Voltage][Electrical][General]** Contractor shall be responsible for providing all equipment, **[j-hooks,][cable tray,][ladder rack]** and associated support, splices, terminating hardware, etc. as necessary to provide a functional cable support system.

B. The Electrical Contractor shall be responsible for providing all back-boxes, pull-boxes, junction boxes, conduit, and sleeves as indicated in the plans and specifications to support the low voltage systems.

C. The **[Low Voltage][Electrical][General]** Contractor shall be responsible for coordinating installation with general contractor and other trades on the job to insure pathways are not impeding other system installations.

D. The term **[Low Voltage][Electrical][General]** Contractor as used in this document refers to the company, group, or individual that has contract responsibility for implementing the terms and directives used in this specification document to produce the finished product as described here-in.

E. The Low Voltage Contractor for this project shall be contracted by the **[Owner][General Contractor/ Electrical Contractor]**.

PART 2 - PRODUCTS

2.1 NON-CONTINUOUS CABLE SUPPORT (J-HOOKS)

A. General

1. J-hooks are the preferred method of installation above accessible ceiling spaces. Cable support shall be at intervals of four (4) feet maximum. Cable pathways shall be designed to avoid EMF and RFI interference. Common causes of this interference are fluorescent lighting fixtures, motors and many kinds of electrical controls including starters, lighting contactors, and power distribution panels. All cable runs must be at least 12-inches away from all fluorescent lights and EMF sources. Any violations of this rule will be corrected at the contractor's Expense.
2. Concern and some evidence exist that certain cable support devices can have a detrimental effect on transmission performance of higher performance cable systems. J-hook cable supports shall provide a bearing surface of sufficient width to comply with the bend radii of high performance cables.
3. J-hooks shall have flared edges to prevent damage while installing cables.
4. J-hooks shall have an electro-galvanized or G 60 finish and shall be rated for indoor use for non-corrosive environments.
5. In no case shall horizontal wire lay on the ceiling or ceiling tile. All horizontal cabling shall maintain a minimum clearance of 6" above ceiling tile and support channels.
6. Never run parallel with electrical conduits or strap to them or any other building service equipment.

B. Acceptable Manufacturers

1. The listing of a manufacturer as "acceptable" does not imply automatic approval. It is the sole responsibility of the Contractor to ensure that any submittals made are for products that meet or exceed the specifications included here.

   a. Chatsworth Products, Inc.
   b. Cooper B-Line
   c. ERICO
   d. Snake Tray by Cable Management Solutions, Inc.

C. Size

1. J-Hooks shall provide a bearing surface of sufficient width to comply with required bend radii of high performance cables. J-hooks shall have a minimum bearing surface of 1 ¾ inches.
2. J-hooks shall have flared edges or be of a design as to relieve stress on cables at the bottom of the bundle that could impinge on the cables performance.
3. Follow Manufactures recommendations for allowable fill capacity for each size J-hook cable support. Typically fill capacity for a Caddy CAT32 type J-hook is 80 Cat 5 cables or 50 Cat 6 cables.

D. Support

1. Acoustical ceiling grid support wire installed with powder-actuated devices may support a J-hook pathway. J-hooks shall be attached to independent grid wire and not attached to the existing ceiling grid wire.

2. J-hooks may be supported by threaded rod. Refer to manufacturers suggested attachment method to attach J-hook to threaded rod using standard nuts.
3. J-hooks may be supported by the use of beam attachments either factory or jobsite assembled either hammer or screw on type, C & Z perlin support, wall, concrete or joist support using factory approved attachment method.

2.2 WIRE BASKET SUPPORT SYSTEM

A. General

1. Provide wire basket of types and sizes indicated; with connector assemblies, clamp assemblies, connector plates and splice bars. Construct units with rounded edges and smooth surfaces and in compliance with applicable standards.
2. Wire basket shall be made of high strength steel wires and formed into a standard 2 inch by 4 inch wire mesh pattern with intersecting wires welded together. All wire ends along wire basket sides (flanges) shall be rounded during manufacturing for safety of cables and installers.
3. Material and finish specifications for each wire basket type are:

   a. Electroplated Zinc: Straight sections shall be made from steel meeting the minimum mechanical properties of ASTM A510 and shall be electro-plated zinc in accordance with ASTB B633 SC2.
   b. Stainless Steel: Straight sections and accessories shall be made from AISI Type 304 Stainless Steel.
   c. Paint: Straight sections shall be painted flat black over electrodeposited zinc, or powder coated.
   d. Pre-Galvanized Zinc: Wall brackets and other pre-galvanized accessories shall be coated with zinc in accordance with ASTM A653.
   e. Black powder coated
   f. Electro-Galvanized Zinc: Support accessories and miscellaneous hardware shall be coated in accordance with ASTM B633 SC3. All threaded components shall be coated in accordance with ASTM B SC1.
   g. Ground cable tray at end of every run.
   h. Bond every section of cable tray to the adjoining tray as per manufacturer’s specifications.
   i. Provide cable drop out brackets at every location where cable exits the tray.
   j. Wire Basket Support System shall be constructed of a minimum of 5mm steal wire.

B. Acceptable Manufacturers

1. Cablofil
2. Chatsworth Products, Inc.
3. Cooper B-line
4. G S Metals
5. Snake Tray by Cable Management Solutions, Inc.

C. Size

1. Wire basket shall conform to the following nominal criteria:

a. Mesh construction: 2 x 4 inches.
b. Straight section lengths of standard 8’ or 10’.
c. Wire basket shall have standard depths of **[1,][2,][4][or][6]** inches as per specifications.
d. Wire basket shall have standard widths of **[2,][4,][6,][8,][12,][18][or][24]** inches as per specifications.
e. Fittings shall be field formed or factory fittings.
f. All section splices shall be made per manufacturer’s standards.

D. Support

1. Wire basket supports shall be either center support hangers, trapeze hangers or wall brackets.
2. Trapeze hangers or support hangers shall be supported by 1/4 inch or 3/8 inch diameter rods.
3. Special accessories shall be furnished as required to protect, support and install a complete wire basket support system.

E. Installation

1. Install wire basket as indicated in accordance with recognized industry practices (NEMA VE-2 2000), to ensure that the cable tray equipment complies with requirements of NEC, and applicable portions of NFPA 70B and NECA’s “ Standards of Installation” pertaining to general electrical practices.
2. Coordinate wire basket with other electrical work as necessary to properly interface installation of wire basket raceway with other work.
3. Provide sufficient space encompassing wire basket to permit access for installing and maintaining cables.
4. Test wire basket support system to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with specified maximum grounding resistance. See NFPA 70B, Chapter 18, for testing and test method.
5. The National Electric Code allows for 50% fill of ventilated cable tray systems as per (Article 392.9 (B)). The cross sectional area of the cables may not exceed 50% of the cross sectional area of the tray

2.3 CONDUITS/SLEEVES

A. General

1. Conduit and sleeve installation is typically a work product of the electrical contractor, however when there is a requirement that the Low Voltage Contractor provide and install conduit runs or sleeve penetrations the following guidelines govern.
2. Conduit/sleeve shall be EMT grade metallic conduit schedule 5 or heavier.

3. Any conduit/sleeve installed for communication cabling shall have a coupler on each end with a plastic bushing for cable protection.
4. Install not more than three 90 degree bends or equivalent between any two pull/termination points.
5. Any section of conduit longer than 150 feet or containing more than two (2) 90 degree bends shall have pull boxes. These boxes will not be shown on drawings. Refer to the table below for pull box sizing.
6. Each conduit bend should be a long sweep radius wherever possible. In no instance shall the inside radius or bend be less than six (6) times the internal diameter of the conduit for conduits that are 2" in diameter or less, for conduits larger than 2" the bend radius shall be no less than 10 (ten) times the inside diameter.
7. Provide nylon or plastic pull strings in all conduit runs.
8. Telecommunications conduits shall be separated from power conduit by not less than 12-inches.
9. All conduits/sleeves shall be secured and strapped to building surfaces per National Electric Code Article 358.30 (A) and (B).

B. Pull Boxes

1. All pull boxes installed in low voltage communications conduit runs shall be sized per Table 4.7 of the BICSI Telecommunications Distribution Methods Manual.

Table 4.7 from the BICSI Telecommunications Distribution Methods Manual, 11th Edition.

Conduit Trade Size mm (in)	Width mm (in)	Length mm (in)	Depth mm (in)	Width Increase for Additional Conduit mm (in)
27 (1)	101 (4)	406 (16)	76 (3)	51 (2)
35 (1-1/4)	152 (6)	508 (20)	76 (3)	73 (3)
41 (1-1/2)	203 (8)	686 (27)	101 (4)	101 (4)
50 (2)	203 (8)	914 (36)	101 (4)	127 (5)
63 (2-1/2)	254 (10)	1067 (42)	127 (5)	152 (6)
78 (3)	305 (12)	1220 (48)	127 (5)	152 (6)
91 (3-1/2)	305 (12)	1370 (54)	152 (6)	152 (6)
100 (4)	381 (15)	1525 (60)	203 (8)	203 (8)

C. Fire Wall Penetrations

1. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."
2. Fire stop penetrations seal methods and materials shall be FM-approved and UL listed as applicable and as approved by the authorities having jurisdiction.
3. Fire stop penetration seal methods and materials shall be FM-approved and UL-listed as applicable and as approved by the authorities having jurisdiction.

4. Responsibility for sealing of opening around the exterior of the low voltage system sleeves shall be by the contractor as described below:

   a. Sleeves through fire rated and smoke walls created by the Low Voltage Contractor for cable pass through shall be the responsibility of the Low Voltage Contractor.
   b. Sleeves through fire rated and smoke walls created by the Electrical Contractor for cable pass through shall be the responsibility of the Electrical Contractor.
   c. Sleeves of openings between floors created by the Low Voltage Contractor for cable pass through shall be the responsibility of the Low Voltage Contractor.
   d. Sleeves of openings between floors created by the Electrical Contractor for cable pass through shall be the responsibility of the Electrical Contractor.

5. Sealing of the space internal to all sleeves or openings used by the Low Voltage Contractor for cable pass through shall be the responsibility of the Low Voltage Contractor.
6. All sleeves shall be of a size as to not have more than 35% of the sleeve filled with low voltage cable at the completion of the installation.
7. All sealing methods shall be submitted to **exp** U.S. Services Inc. for review prior to sealing.
8. Maximum diameter of opening is 5 ½ inches.
9. Maximum nominal diameter steel pipe sleeve (schedule 5 or heavier).
10. Minimum 1” thickness mineral wool (min. 4 PCF density) tightly packed.
11. Minimum 1” thickness firestop putty stick.
12. Minimum 5/8” depth firestop putty stick or intumescent firestop sealant.
13. Steel pipe sleeve may be flush with wall surface or extend up to 18” beyond wall surface in any combination, when sleeve is flush with wall, apply putty stick onto wall surface completely covering pipe sleeve, when sleeve is extended beyond one or both sides of wall, apply minimum ½” bead intumescent firestop sealant or firestop putty stick to wall/pipe sleeve interface.

2.4 BACKBOARDS

A. Backboards: Plywood, **[fire-retardant treated,][**3/4 by 48 by 96 inches (19 by 1220 by 2440 mm)**]**. Comply with requirements for plywood backing panels in Division 06 Section "Rough Carpentry".

2.5 EQUIPMENT FRAMES

A. General

1. The Low Voltage Contractor shall provide vertical cable management between each rack and at the end of each row of racks. Waterfall cable management shall be provided at the top of the rack for patch cords and for horizontal cables entering the rack channels from cable tray for protection and to maintain proper bend radius and cable support. Horizontal wire management shall be mounted below each patch

panel and/or piece of equipment on the rack. The horizontal wire management shall be a minimum of **[one][two]** rack-units (RU), refer to project plans for exact size and description. The rack shall include mounting brackets for cable tray ladder rack to mount to the top of the rack as required. Velcro cable ties shall be provided inside the rack channels to support the horizontal cable. Rack shall be black in color to match the patch panels and cable management.

B. Free-Standing Two-Post Equipment Rack <Edit for the type of frames that will be utilized.>

1. Approved Manufacturer

a. APC
b. Chatsworth Products, Inc.
c. Great Lakes Case and Cabinet Co. Inc.
d. Ortronics, A Legrand Company
e. Panduit
f. <**Insert Note Here**>

2. Free-standing rack shall:

a. Provide the necessary strain relief, bend radius and cable routing for proper installation of high performance cross connect products, meeting all specifications of ANSI/TIA/EIA-568-B.
b. Have top cable trough with waterfall and built in patch/horizontal cable distribution separator.
c. Have with a 6” channel depth.
d. Have hook and loop straps for securing bulk cables inside the vertical U-channels.
e. Provide standard EIA 19” channel front and rear.
f. Have a height of 7’-0”.
g. Provide 45 RMU of equipment space.
h. Universal 5/8”-5/8”-1/2” hole pattern.
i. Have vertical patch cord management.
j. Shall be UL listed.
k. Provide vertical cable management between each rack and at the end of each row. Refer to project plans for sizing.
l. Provide horizontal wire management below each patch panel and each piece of equipment located in the equipment rack. Refer to project plans for sizing.

C. Free-Standing Four-Post Equipment Rack

1. Approved Manufacturer

a. APC
b. Chatsworth CPI
c. Great Lakes Case and Cabinet Co. Inc.
d. Middle Atlantic

e. Ortronics, A Legrand Company
f. Panduit
g. <**Insert Note Here**>

2. Free-standing rack shall:

a. Provide the necessary strain relief, bend radius and cable routing for proper installation of high performance cross connect products, meeting all specifications of ANSI/TIA/EIA-568-B.
b. Have top cable trough with waterfall and built in patch/horizontal cable distribution separator.
c. Have with a 6" channel depth.
d. Distance between channels shall be a minimum of 29".
e. Have hook and loop straps for securing bulk cables inside the vertical U-channels.
f. Provide standard EIA 19" channel front and rear.
g. Have a height of 7'-0".
h. Provide 45 RMU of equipment space.
i. Universal 5/8"-5/8"-1/2" hole pattern.
j. Have vertical patch cord management.
k. Shall be UL listed.
l. Provide vertical cable management between each rack and at the end of each row. Refer to project plans for sizing.
m. Provide horizontal wire management below each patch panel and each piece of equipment located in the equipment rack. Refer to project plans for sizing.

D. Wall Mounted Equipment Rack

1. Approved Manufacturer

a. Chatsworth CPI
b. Great Lakes Case and Cabinet Co. Inc.
c. Middle Atlantic.
d. <**Insert Note Here**>

2. Provide the necessary strain relief, bend radius and cable routing for proper installation of high performance cross connect products, meeting all specifications of ANSI/TIA/EIA-568-B.
3. Provide standard EIA 19" channel front and rear.
4. Universal 5/8"-5/8"-1/2" hole pattern.
5. Shall be UL listed.
6. Swing Gate Wall Rack

a. Dual hinges to open either right or left stopping in the 90 degree position.
b. Locking latch pin to secure gate in closed position.
c. Support 100 lbs. of equipment when open.
d. Provide a minimum of 11" usable depth for equipment.

e. Provide horizontal wire management below each patch panel and each piece of equipment located in the equipment rack. Refer to project plans for sizing.

7. Wall Mounted Equipment Cabinet

a. Provide a zero clearance latch for side by side mounting.
b. Locking rear swing frame with heavy duty quick release hinges.
c. Support 200 lbs. of equipment when open.
d. 1/2", 3/4", 1", 1-1/2", 2" and 3" electrical knockouts on top and bottom of mounting frame.
e. Two (2) knockouts on top and bottom for fan mounting.
f. Vented sides and top.
g. Solid, plexi-glass, vented front door.
h. Provide horizontal wire management below each patch panel and each piece of equipment located in the equipment rack. Refer to project plans for sizing.

8. Vertical Wall Cabinet:

a. Provide a minimum 4" x 6" opening in rear of cabinet for cable entrance and exit.
b. Provide 1/2", 3/4", 1" and 1-1/2" electrical knockouts.
c. Removable top panel.
d. Feature 2" x 4" junction box for electrical receptacle.
e. Support 100 lbs. of equipment.
f. Provide horizontal wire management below each patch panel and each piece of equipment located in the equipment rack. Refer to project plans for sizing.

E. Free-Standing Equipment Enclosure:

1. Approved Manufacturer:

a. APC
b. Chatsworth CPI
c. Rittal
d. Middle Atlantic
e. Ortonics, A Legrand Company
f. Panduit
g. **<Insert Note Here>**

2. Free-standing rack shall:

a. Provide the necessary strain relief, bend radius and cable routing for proper installation of high performance cross connect products, meeting all specifications of ANSI/TIA/EIA-568-B.
b. Have top cable trough with waterfall and built-in patch/horizontal cable distribution separator.
c. Have a 6" channel depth.
d. Distance between channels shall be a minimum of 29".

e. Have hook and loop straps for securing bulk cables inside the vertical U-channels.
f. Provide standard EIA 19" channel front and rear.
g. Have a height of 7'-0".
h. Provide 45 RMU of equipment space.
i. Universal 5/8"-5/8"-1/2" hole pattern.
j. Provide vertical cable management within the enclosure.
k. Allow for active or passive thermal management.
l. Solid, plexi-glass, vented front door.
m. Solid, partially vented, fully vented rear door.
n. Key locked solid side panels.
o. Shall be UL listed.

PART 3 - EXECUTION

3.1 CABLE PATHWAYS

A. Pathways will be constructed from J-hooks hung from ceiling wire installed with powder-actuated devices, wire basket trays supported by threaded rod or wall brackets, ladder rack supported by threaded rod or wall brackets or conduit supported as per the NEC. J-hooks shall be attached to independent grid wire and not attached to the existing drop ceiling grid wiring. The added weight to the ceiling grid system can cause distortion in the grid system.

3.2 INSTALLATION

A. Provide conduit system as shown on the drawings and as specified herein.

B. Terminate metal conduit using connectors with plastic bushings..

C. In finished areas, conceal conduits and flush mount boxes.

D. Provide nylon or plastic pull string in all conduit runs.

E. Ground conduits at terminal boards with grounding bushings.

F. Telecommunications conduits shall be separated from power conduits by not less than 12-inches.

G. Conduit installation shall be coordinated with their respective termination equipment layouts at each backboard location as required to provide adequate dedicated space for equipment provided and installed by Owner's communication vendor(s).

H. Any section of conduit longer than 150 feet or containing more than two (2) 90 degree bends shall have pull boxes. These boxes are not shown on drawings.

I. Install all pathway systems as per manufacturers recommended practices and as per local governmental regulations and NEC, and BICSI regulations and practices.

J. Cable pathways

1. A dedicated pathway shall be provided for **[structured cabling system][security system][, and audio visual system]**. Coordinate locations and sizes with each system's **[Low Voltage Contractor,][Electrical Contractor,]**General Contractor**[and Owner's representative].[Nurse call system cabling shall be separated from all other pathways.]< Remove for all non-healthcare projects.>**

K. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.

3.3 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."

B. Comply with TIA/EIA-569-A, "Firestopping" Annex A.

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.4 GROUNDING

A. For communications wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. For low-voltage wiring and cabling, comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

3.5 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

END OF SECTION

SECTION 28 13 00 - ELECTRONIC ACCESS CONTROL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 RELATED WORK AND REQUIREMENTS

A. Section 27 05 00 – Common Work Results for Communications

B. Section 27 05 26 – Grounding and Bonding for Communications Systems

C. Section 27 05 28 – Pathways for Communications Systems

D. Section 27 11 00 – Communications Equipment Room Fittings

E. Section 27 13 00 – Communications Backbone Cabling

F. Section 27 15 00 – Communications Horizontal Cabling

G. Section 28 05 00 – Common Work Results for Safety and Security

H. Section 28 05 13 – Conductors and Cables for Electronic Safety and Security

I. Section 28 23 00 – Video Surveillance Equipment

1.3 SUMMARY

A. Section includes an access control and alarm monitoring system consisting of an access control and alarm monitoring system consisting of Security access device, Access Control panel, Input / Output and Card Reader Interface Modules, Accessory relays, Alarm signaling devices, Cabling, Power Supplies and Equipment Enclosures, End of Line Terminations, Surge Protection, System Configuration, Commissioning and Programming.

1.4 DEFINITIONS

A. ABA Track: Magnetic stripe that is encoded on track 2, at 75-bpi density in binary-coded decimal format; for example, 5-bit, 16-character set.

B. CCTV: Closed-circuit television.

C. Central Station: A PC with software designated as the main controlling PC of the security access system. Where this term is presented with initial capital letters, this definition applies.

D. Controller: An intelligent peripheral control unit that uses a computer for controlling its operation. Where this term is presented with an initial capital letter, this definition applies.

E. CPU: Central processing unit.

F. Credential: Data assigned to an entity and used to identify that entity.

G. dpi: Dots per inch.

H. DTS: Digital Termination Service: A microwave-based, line-of-sight communications provided directly to the end user.

I. File Server: A PC in a network that stores the programs and data files shared by users.

J. GFI: Ground fault interrupter.

K. Identifier: A credential card, keypad personal identification number or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.

L. I/O: Input/Output.

M. LAN: Local area network.

N. LED: Light-emitting diode.

O. Location: A Location on the network having a PC-to-Controller communications link, with additional Controllers at the Location connected to the PC-to-Controller link with RS-485 communications loop. Where this term is presented with an initial capital letter, this definition applies.

P. PC: Personal computer. This acronym applies to the Central Station, workstations, and file servers.

Q. PCI Bus: Peripheral component interconnect; a peripheral bus providing a high-speed data path between the CPU and peripheral devices (such as monitor, disk drive, or network).

R. PDF: (Portable Document Format.) The file format used by the Acrobat document exchange system software from Adobe.

S. RF: Radio frequency.

T. ROM: Read-only memory. ROM data are maintained through losses of power.

U. RS-232: A standard for asynchronous serial data communications between terminal devices. This standard defines a 25-pin connector and certain signal characteristics for interfacing computer equipment.

V. RS-485: A standard for multipoint communications.

W. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

X. TWAIN: (Technology without an Interesting Name.) A programming interface that lets a graphics application, such as an image editing program or desktop publishing program, activate a scanner, frame grabber, or other image-capturing device.

Y. UPS: Uninterruptible power supply.

Z. WAN: Wide area network.

AA. WAV: The digital audio format used in Microsoft Windows.

BB. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.

CC. Windows: Operating system by Microsoft Corporation.

DD. Workstation: A PC with software that is configured for specific limited security system functions.

EE. WYSIWYG: (What You See Is What You Get.) Text and graphics appear on the screen the same as they will print.

1.5 SYSTEM DESCRIPTION

A. Security Access Control and Alarm Monitoring System: This system shall contain the equipment, software, and components to provide IP based Security Access Control and Alarm Monitoring System. The scope of this work includes all Access Control and Alarm Monitoring System devices and equipment within this facility, connection to the Client provided network, commissioning with and at the direction of the Client's central monitoring system master security integrator, commissioning and acceptance testing.

1. Intelligent System Controller
2. Alarm Monitoring and Card Access System (AM&CS) Server
3. Alarm Monitoring and Card Access System Workstation
4. Credential Management Workstation
5. Card Printer
6. Photo Capture KIT

7. Input Control Module
8. Output Control Module
9. Card Reader Interface Modules
10. Power supply and charger
11. Indoor wall mount type enclosures to house
12. Encoded Card Readers
13. Surge protectors
14. Door position monitoring reed switches
15. Guest Assistant button
16. Duress alarm buttons
17. Audible sounders and strobe lights
18. Lockable metal equipment cabinets with tamper alarm/s for door/cover and removal from the wall
19. Tamper alarms on all junction boxes inside and outside the building
20. Restroom Assistant Switch
21. Motion Detectors
22. Metal Detector
23. X-Ray
24. Turnstile
25. Perimeter Video Analytics (Cross-Line)
26. Perimeter Electronic fence system (Cable sensor)
27. Guard Tour Stations
28. Day/Night Switch
29. Security system non-network cabling
30. Push Button Switch
31. Electric Door Strike
32. Electromagnetic Lock
33. Access Control System Software
34. All other components in order to complete a fully functioning system

B. All the Security Access Control and Alarm Monitoring Equipment shall be powered from the building UPS.

C. The system can coordinate with other systems, such as building automation, CCTV, burglar alarm, fire control and other systems through linkage output points; When the Security Access Control system receives the fire alarm signal, the system can automatically open all the door locked in the related area, which is beneficial to the people in the control area to escape. In conjunction with the cameras set up in the important area, when the abnormal door opening event occurs (as if door is pried), the system should automatically switch the camera's screen at the same time of alarm, and monitor and record the location.

D. Interlock function: in two interlocked doors, when one door is open, the other must be locked, multi door interlocking should be supported.

E. Support online patrol function.

F. Support anti-passback and anti-tailing function: in some areas, cardholders are only allowed to use ID cards in the order of first in last out, preventing the cardholder to lend the card to others to use or follow.

G. The card reader and controller shall have compatibility with Wiegand and OSDP protocol.

1.6 PERFORMANCE REQUIREMENTS

A. Security access system shall use a single database for access-control and credential-creation functions.

B. Distributed Processing: System shall be a fully distributed processing system so that information, including time, date, valid codes, access levels, and similar data, is downloaded to Controllers so that each Controller makes access-control decisions for that Location. Do not use intermediate Controllers for access control. If communications to Central Station are lost, all Controllers shall automatically buffer event transactions until communications are restored, at which time buffered events shall be uploaded to the Central Station.

C. System Network Requirements:

1. Interconnect system components and provide automatic communication of status changes, commands, field-initiated interrupts, and other communications required for proper system operation.
2. Communication shall not require operator initiation or response, and shall return to normal after partial or total network interruption such as power loss or transient upset.
3. System shall automatically annunciate communication failures to the operator and identify the communication link that has experienced a partial or total failure.

D. Central Station shall provide operator interface, interaction, display, control, and dynamic and real-time monitoring. Central Station shall control system networks to interconnect all system components, including workstations and field-installed Controllers.

E. Field equipment shall include Controllers, sensors, and controls. Controllers shall serve as an interface between the Central Station and sensors and controls. Data exchange between the Central Station and the Controllers shall include down-line transmission of commands, software, and databases to Controllers. The up-line data exchange from the Controller to the Central Station shall include status data such as intrusion alarms, status reports, and entry-control records. Controllers are classified as alarm-annunciation or entry-control type.

1.7 SUBMITTALS

A. Refer to Section 28 05 00, “Common Work Results for Safety and Security” for general Submittal information and requirements.

B. Action Submittals

1. Product Data: For each type of product indicated. Include dimensions and data on features, performance, electrical characteristics, ratings, and finishes.
2. Shop Drawings: For Access control. Include plans, elevations, sections, details, and attachments to other work.

a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
b. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
c. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
d. UPS: Sizing calculations.
e. Wiring Diagrams: For power, signal, and control wiring.

3. Equipment List: Include every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.
4. All submitted product sheets containing more than one product or multiple product options shall have the submitted product clearly identified for review with all options highlight as intended for review.

PART 2 - PRODUCTS

2.1 SYSTEM REQUIREMENTS

A. All Electronic Access Control Controllers shall be provided with the appropriate licenses as required to provide a fully functional system.

B. All control equipment and operator stations shall be provided with the appropriate user clients and licenses as required to provide a fully functional system.

C. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components.

1. Provide Surge Protection at each end of all copper cables routed beyond the building envelope between field devices and control equipment. Refer to specification section 26 43 13 – Surge Protective Devices for Low-Voltage Electrical Power Circuits.

2.2 SECURITY ACCESS SYSTEM CONTROLLERS

A. Manufacturers:

1. Honeywell
2. or approved manufacturer

2.3 APPLICATION SOFTWARE

A. System Software:

1. DNA Fusion
2. Genetec
3. Milestone
4. or approved manufacturer

2.4 CARD READERS

A. Power: Card reader shall be powered from its associated Controller, including its standby power source.

B. Response Time: Card reader shall respond to passage requests by generating a signal that is sent to the Controller. Response time shall be 800 ms or less, from the time the card reader finishes reading the credential card until a response signal is generated.

C. Display: LED or other type of visual indicator display shall provide visual status indications and user prompts. Indicate power on/off, whether user passage requests have been accepted or rejected, and whether the door is locked or unlocked.

D. Proximity Readers:

1. Multi-technology passive detection proximity card readers shall use a swept-frequency, RF field generator to read the resonant frequencies of tuned circuits laminated into compatible credential cards. The resonant frequencies read shall constitute a unique identification code number.
2. The card reader shall read proximity cards in a range from contact with to at least 6 inches from the reader.

2.5 PUSH-BUTTON SWITCHES

A. Manufacturers:

1. Securitron Magnalock Corporation; an ASSA ABLOY Group Company.

B. Push-Button Switches: Momentary-contact back-lighted push buttons, with stainless-steel switch enclosures.

1. Electrical Ratings:

a. Minimum continuous current rating of 10 A at 120 V ac.
b. Contacts that will make 720 VA at 60 A and that will break at 720 VA at 10 A.

2. Enclosures: Flush or surface mounting. Push buttons shall be suitable for flush mounting in the switch enclosures.
3. Enclosures shall additionally be suitable for installation in the following locations:

a. Indoors, controlled environment.
b. Indoors, uncontrolled environment.
c. Outdoors.

4. Power: Push-button switches shall be powered from their associated Controller, using dc control.

2.6 DOOR AND GATE HARDWARE INTERFACE

A. Exit Device with Alarm: Operation of the exit device shall generate an alarm.

B. Exit Alarm: Operation of a monitored door shall generate an alarm.

C. Electric Door Strikes: Use end-of-line resistors to provide power line supervision. Signal switches shall transmit data to Controller to indicate when the bolt is not engaged and the strike mechanism is unlocked, and shall report a forced entry. Power and signal shall be from the Controller.

D. Electromagnetic Locks: End-of-line resistors shall provide power line supervision. Lock status sensing signal shall positively indicate door is secure. Power and signal shall be from the Controller.

E. Vehicle Gate Operator: Interface electrical operation of gate with controls of this Section. Vehicle gate operators shall be connected, monitored, and controlled, by the security access Controllers.

2.7 CABLES

A. Unshielded Twisted Pair (UTP) Cable

1. Refer to Division 27 Section 27 15 00 for UTP cable requirement.

B. RS-485 Cable

1. Refer to Division 28 Section 28 05 13 for RS-485 cable requirement.

C. Access Control Cable

1. Refer to Division 28 Section 28 05 13 for access control cable requirement.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for LAN and control cable conduit systems to PCs, Controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Comply with recommendations in SIA CP-01.

B. Comply with TIA-606, "Administration Standard for the Telecommunications Infrastructure of Commercial Buildings."

C. Obtain detailed Project planning forms from manufacturer of access-control system; develop custom forms to suit Project. Fill in all data available from Project plans and specifications and publish as Project planning documents for review and approval.

1. Record setup data for control station and workstations.
2. For each Location, record setup of Controller features and access requirements.
3. Propose start and stop times for time zones and holidays, and match up access levels for doors.
4. Set up groups, facility codes, linking, and list inputs and outputs for each Controller.
5. Assign action message names and compose messages.
6. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
7. Prepare and install alarm graphic maps.
8. Develop user-defined fields.
9. Develop screen layout formats.

10. Propose setups for guard tours and key control.
11. Discuss badge layout options; design badges.
12. Complete system diagnostics and operation verification.
13. Prepare a specific plan for system testing, startup, and demonstration.
14. Develop acceptance test concept and, on approval, develop specifics of the test.
15. Develop cable and asset management system details; input data from construction documents. Include system schematics and Visio Technical Drawings.

D. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

3.3 CABLING

A. Comply with requirements in Section 27 05 28, “Communications Raceway Systems”.

B. Comply with requirements in Section 27 15 00. “Communications Horizontal Cabling”.

C. Wiring Method: Install cables in conduit unless otherwise indicated.

1. Except raceways are not required in accessible indoor ceiling spaces and attics.
2. Except raceways are not required in hollow gypsum board partitions.
3. Conceal raceways and wiring except in unfinished spaces.

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

E. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

F. For copper LAN connections and fiber-optic communication wiring, comply with Section 27 15 00. “Communications Horizontal Cabling” and Section 27 13 00, “Communications Backbone Cabling”.

G. Install cables without damaging conductors, shield, or jacket.

H. Boxes and enclosures containing security system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered to be accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.

I. Install end-of-line resistors at the field device location and not at the Controller or panel location.

3.4 CABLE APPLICATION

A. Comply with TIA-569, "Commercial Building Standard for Telecommunications Pathways and Spaces."

B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.

C. RS-485 Cabling: Install at a maximum distance of 4000 feet (1200 m).

D. Card Readers:

1. Install number of conductor pairs recommended by manufacturer for the functions specified.

2. Unless manufacturer recommends larger conductors, maximum distance is 100 m.
3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the Controller.

3.5 GROUNDING

A. Comply with Section 27 05 26, “Grounding and Bonding for Communications Systems."

B. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

C. Bond shields and drain conductors to ground at only one point in each circuit.

D. Signal Ground:

1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
2. Bus: Mount on wall of main equipment room with standoff insulators.
3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

3.6 INSTALLATION

A. Push Buttons: Where multiple push buttons are housed within a single switch enclosure, they shall be stacked vertically with each push-button switch labeled with text and symbols as required. Push-button switches shall be connected to the

Controller associated with the portal to which they are applied, and shall operate the appropriate electric strike, electric bolt, or other facility release device.

B. The contractor shall be responsible for all system programing as to provide the owner with a fully functional system per the owner's operational requirements. Coordinate exact requirements with owner's representative prior to installation.

3.7 IDENTIFICATION

A. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.

B. At completion, cable and asset management software shall reflect as-built conditions.

3.8 SYSTEM SOFTWARE

A. Develop, install, and test software and databases for the complete and proper operation of systems involved. Assign software license to Owner.

3.9 STARTUP SERVICE

A. Engage an owner's representative to supervise and assist with startup service. Complete installation and startup checks according to approved procedures that were developed in " Preparation" Article and with manufacturer's written instructions.

1. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain security access system.

B. Develop separate training modules for the following:

1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.

3. Security personnel.
4. Hardware maintenance personnel.
5. Corporate management.

END OF SECTION